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THE PHILIPPINE JOURNAL OF SCIENCE

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CITRUS-CANKER CONTROL: A PROGRESS REPORT OF EXPERIMENTS

By H. ATHERTON LEE[1]

Mycologist, Bureau of Science, Manila[2]

TWO PLATES

INTRODUCTION

Field investigations on citrus canker in the continental United States have been impossible in the past because of the regulations which have been promulgated to make eradication work possible. For this reason, investigations on citrus-canker control were undertaken in the Philippine Islands in the summer of 1917. The primary purpose of these experiments was to determine whether citrus canker could be controlled by means other than total eradication; that is, by the use of fungicides and cultural methods. It was believed that, even though such control methods should not prove successful, methods and ideas might arise which would be of value in aiding citrus-canker eradication in the southern United States.

[1] The writer wishes to express appreciation to Col. Adriano Hernandez, director, and Mr. S. Apostol, chief of the plant industry division of the Philippine Bureau of Agriculture, for the great assistance and the many facilities afforded him. It is to them that thanks are due for the use of the citrus collection at Lamao, Philippine Islands. Similar deep appreciation is expressed to Prof. C. F. Baker, dean of the College of Agriculture, University of the Philippines, for the use of the citrus collection at Los Baños during these experiments and for assistance in many other ways. Thanks are also due to Father M. Selga, of the Weather Bureau, for very kindly assistance in supplying climatological data.

[2] The work was begun while the writer was under the direction of the United States Department of Agriculture, and credit is due to that institution for the inauguration of this work.

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The writer wishes this paper to be considered as merely a progress report, since past work has been of value mainly in indicating the great differences in susceptibility of the commercial *Citrus* species and varieties and the differences in effort necessary for the control of canker on such different species and varieties. Such methods of control as have been successful to some extent are also reported here.

DISTRIBUTION OF CANKER IN THE PHILIPPINES

The citrus industry in the Philippines consists for the most part in the production of mandarin oranges (*Citrus nobilis*) from seedling trees; a few seedling sweet-orange trees (*Citrus sinensis*), a few pummelo trees (*Citrus maxima*), and calamondin (*Citrus mitis*) trees are also grown. The largest center of production of citrus fruits is Batangas Province, south of Manila.

In some of the outlying islands citrus canker has not been found as yet, which has given rise to the suggestion of Mackie (14) that canker has not existed in the Philippines for a great period of time. Although Wester(20) has shown the presence of citrus canker in the isolated Batanes (the small islands lying between Luzon and Formosa) as early as 1909, he has found it to be entirely absent from certain regions of Mindanao and Sulu Archipelago. This, then, would corroborate the suggestion of Mackie. For the purpose of this paper, in any case, it is sufficient to note that canker is distributed throughout Batangas and Laguna Provinces and the citrus plantings of the Manila Bay region where the experiments were carried on.

The main control work was begun at two places; in the orchards of the Lamao agricultural experiment station of the Philippine Bureau of Agriculture, and in the citrus plantings, in Los Baños, of the College of Agriculture of the University of the Philippines. Control work was not attempted on the plantings of private holders since they consisted for the most part of mandarin orange trees which are in most cases resistant to citrus canker.

CLIMATIC CONDITIONS OF THE REGION SURROUNDING MANILA

An understanding of the climatic conditions at Lamao and Los Baños is essential before undertaking a discussion of the control work.

Briefly, at Lamao and Los Baños, the year is divided into two seasons; the wet season, beginning generally about the middle of May and ending in November, and the dry season, beginning the latter part of November or early December and lasting until the

early part of May. Table 1, compiled from the reports of the Philippine Weather Bureau, shows the monthly rainfall in detail during 1914, 1915, and 1916 at Manila. The rainfall at Lamao is, sometimes at least, slightly less than that at Manila, while that at Los Baños may be said to be usually slightly greater.

TABLE 1.—*Rainfall recorded by the Central Observatory at Manila of the Philippine Weather Bureau.*

Month.	1914			1915			1916		
	Total.	Daily maximum.	Rainy days.	Total.	Daily maximum.	Rainy days.	Total.	Daily maximum.	Rainy days.
	mm.	*mm.*		*mm.*	*mm.*		*mm.*	*mm.*	
January	3.5	1.7	3	5.6	3.5	5	38.2	20.8	7
February	7.3	3.3	4	3.8	3.8	1	23.6	20.7	4
March	6.1	5.1	2	3.3	2.4	4	29.1	16.8	5
April	53.4	26.2	8	0.5	0.5	1	46.2	33.8	5
May	84.0	43.8	11	50.4	13.5	9	39.8	9.3	15
June	367.9	109.7	13	126.7	53.6	10	224.6	72.9	17
July	399.3	71.2	23	276.3	80.0	20	179.9	46.0	25
August	492.3	96.6	25	413.8	63.2	23	282.3	43.7	24
September	887.7	234.7	21	478.7	103.3	21	372.6	74.2	25
October	40.2	18.0	12	165.4	27.5	19	223.6	43.0	25
November	41.0	29.8	7	208.1	105.4	15	106.5	21.6	15
December	52.4	15.0	14	182.3	68.7	13	76.0	16.2	13

A study of this table will give an idea of the time and amount of rainfall throughout a normal year.

TABLE 2.—*Temperatures recorded by the Central Observatory at Manila of the Philippine Weather Bureau.*

Month.	1914			1915			1916		
	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.
	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.	°C.
January	23.7	32.7	14.5	24.8	32.6	17.5	24.8	32.8	17.4
February	24.2	33.1	16.3	25.7	34.2	17.3	25.3	33.2	16.9
March	26.5	35.7	17.6	26.8	36.4	18.9	26.4	34.9	20.0
April	28.0	36.9	19.2	28.7	38.0	20.6	27.3	35.0	20.4
May	28.5	37.7	21.4	29.2	38.6	22.6	27.4	35.5	22.0
June	27.4	35.5	22.7	28.8	36.9	23.3	27.1	35.1	22.3
July	27.0	33.5	22.7	27.6	36.3	22.1	26.9	34.1	22.4
August	27.0	34.1	22.1	26.9	32.9	22.5	27.2	33.5	22.0
September	26.2	34.1	22.2	26.8	33.4	22.4	26.0	33.3	22.3
October	25.9	33.4	20.0	26.6	33.9	22.4	25.9	33.8	21.6
November	26.0	33.7	19.7	26.0	33.6	21.4	25.7	32.0	19.5
December	25.3	33.4	18.4	25.4	32.2	19.8	34.9	32.2	17.4

The temperatures at either Lamao or Los Baños are fairly high, with comparatively slight seasonal variations. The table

of temperatures (Table 2) is also taken from the reports of the Weather Bureau of the Philippine Government, and represents Manila temperatures.

The temperatures at Manila may be taken as an index of the temperatures at both Los Baños and Lamao. The temperatures at Lamao and at Los Baños, therefore, are probably favorable at all times for the dissemination and the development of citrus canker.

The humidity remains fairly high throughout the months of the dry season as is shown by Table 3.

TABLE 3.—*Relative humidity at Manila, compiled from the annual reports of the Philippine Weather Bureau.*

Month.	1914			1915			1917		
	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
January	76.2	98.0	48.5	78.6	99.0	50.5	77.9	97.0	44.0
February	73.8	95.0	42.0	69.5	96.0	35.5	78.1	99.0	47.0
March	68.6	94.0	32.0	70.9	97.0	37.0	73.4	97.0	39.0
April	70.8	97.0	34.0	66.0	96.0	32.0	75.0	98.0	47.0
May	72.6	100.0	38.0	75.1	99.0	39.0	77.8	97.0	45.0
June	81.7	99.0	54.0	75.5	100.0	36.0	83.5	99.0	50.0
July	85.4	99.0	60.0	83.5	99.0	51.0	85.0	99.0	59.0
August	83.0	99.0	50.0	87.3	100.0	60.0	84.0	100.0	57.5
September	87.3	98.0	58.0	86.4	99.0	59.0	88.4	99.0	61.0
October	79.7	99.0	42.0	85.9	99.0	56.5	87.6	99.0	56.0
November	78.4	99.0	44.0	85.3	98.0	52.0	83.9	99.0	47.0
December	82.0	99.0	48.0	83.5	96.0	51.5	84.3	99.0	48.0

Although the humidity and the temperature are favorable throughout the dry months, it is apparent that canker development is inactive and passive during these months. The explanation for this inactivity, corroborated by close field observation, is that citrus canker apparently is dependent for its dissemination upon free moisture on the leaves, in the form of either rain or dew. The dry season from December to May, therefore, is a limiting factor in the development of citrus canker in the Philippines. The long days of steady, direct sunlight during the dry season are also apparently a limiting factor to the spread of the canker organism.

The dry season is correlated more or less with a steady northeast monsoon, while the wet season is correlated with a southwest monsoon. The velocity of these winds can be judged from Table 4, also compiled from the reports of the Philippine Weather Bureau.

TABLE 4.—*Representative wind velocities in Manila, expressed in kilometers per hour, compiled from the annual reports of the Philippine Weather Bureau.*

Month.	1914			1915			1916		
	Daily mean.	Hourly maximum.	Daily minimum.	Daily mean.	Hourly maximum.	Daily minimum.	Daily mean	Hourly maximum.	Daily minimum.
	km.	*km.*	*km.*	*km.*	*km.*	*km.*	*km.*	*km.*	*km.*
January	158.9	28.0	82.5	116.0	27.5	39.0	214.1	36.0	100.5
February	187.7	26.0	104.0	172.5	27.5	66.0	166.0	25.5	63.5
March	204.6	28.5	105.5	190.7	28.0	100.0	188.8	24.0	125.5
April	197.4	34.0	90.5	227.8	31.0	150.0	186.4	26.0	118.5
May	198.0	34.0	92.0	235.4	35.0	128.0	180.7	31.0	122.5
June	223.8	64.0	70.5	174.6	43.0	84.5	185.4	39.5	84.5
July	348.1	53.0	70.5	209.2	36.5	79.0	169.3	32.5	29.0
August	360.4	53.0	44.5	258.7	42.0	98.5	328.0	43.0	52.0
September	244.7	41.0	73.0	184.4	36.0	38.0	186.1	42.0	76.0
October	124.6	22.0	67.0	206.6	58.0	65.0	110.8	22.0	52.0
November	126.2	23.0	65.5	156.6	68.0	64.5	139.7	25.0	84.5
December	108.0	18.0	50.5	167.5	68.0	62.5	145.0	23.5	90.0

During the summer season cyclonic disturbances are frequent, when wind velocities of 60 or more kilometers an hour are not unusual, and even a velocity of 195 kilometers an hour has been recorded by the Weather Bureau. Such winds are usually accompanied by rainfall and are a serious handicap in combating citrus canker, in as much as they disseminate the canker organism at a time when all conditions favor the development of canker. More extensive data and references upon the climate of the Philippines may be obtained in the publication of Father Coronas,(4) of the Philippine Weather Bureau.

PREVIOUS LITERATURE UPON CONTROL METHODS FOR CITRUS CANKER

The available literature on investigations upon the control of citrus canker is not extensive. The first note of the effect of spraying against citrus canker is that of Wester,(18) who, in the dry season of 1912 in the Philippines, was able, by application of Bordeaux mixture, to control a disease which he regarded as citrus scab. In the wet season, however, he reports his spraying methods to have been unsuccessful against the disease. He later identified the disease as citrus canker instead of citrus scab. Stevens(16, 17) has reported spraying conducted by growers and nurserymen against canker in Florida to be impracticable, but has not described the spraying methods employed. Wolf(21) described control methods using variations of Bordeaux mixture against the disease on grapefruit trees in

Alabama. His conclusions are best obtained by a direct quotation from his publication:

> All visible signs of canker were carefully removed from the trees prior to the application of the mixtures. Bordeaux mixture, Bordeaux mixture and bichlorid of mercury (12 tablets in 3 gallons), Bordeaux mixture and formaldehyde (1:100), and a Bordeaux and lead arsenate mixture were employed. Applications were made on March 26, April 29, and May 14, and no new infections had developed on any of the sprayed or unsprayed trees by the last named date. On May 27, however, new infections were apparent and were equally numerous on sprayed and check trees.

These results of course apply only to the grapefruit, the most susceptible host.

Doryland(6) has reported successful results of spraying experiments against citrus canker upon seedling trees of calamondin, mandarin, and sweet-orange varieties in nursery rows at the Singalong experiment station in Manila, Philippine Islands. He found that spraying with Bordeaux mixture 4–6–50 met with little or no success when used in the rainy season, but later he obtained favorable results by using formalin in a 1 to 100 solution at ten-day intervals. Doryland does not give his dates of spraying, but a survey of his statements as to time of application leads to the conclusion that his favorable results with formalin were obtained in the dry season, when active dissemination of citrus canker is limited. His later report(7) states that applications at ten-day intervals of Bordeaux mixture 4–6–50, plus formalin to make a 0.4 per cent solution, were able to rid the plants of canker in four months. His spraying was begun January 29; therefore, four months would bring his experiments to a conclusion on May 29. January, February, March, April, and May are dry months in the Manila Bay region, as Table 1 has shown. By using creolin-formalin emulsion, Doryland was able to decrease canker during the first four months, but during the fifth month there was a bad increase in canker. The fifth month would be June, which has a very heavy rainfall. Thus it would seem as if Doryland's data may be taken to show that canker can be controlled in the dry months, but that his results do not apply to the rainy season when canker dissemination and development are active. This conclusion would bear out Wester's result.

Doidge(5) reports that citrus canker was controlled with Bordeaux mixture 4–4–50 under conditions in the Transvaal, where there is a long dry season. She does not give the host upon which the control was obtained.

Kellerman(8) advised spraying healthy trees with a 1 per

cent formalin solution to avoid infection, but the recommendation apparently was not based upon experimental evidence.

Spraying experiments upon Washington navels in Japan have been reported by several Japanese investigators and were apparently successful to some degree as practiced by the investigators. Growers of Washington navels in Japan at present, however, have given up such spraying as unsuccessful in a number of cases. A more detailed review of the Japanese literature will be presented in a later publication.

THE CONTROL EXPERIMENTS OF THE PRESENT INVESTIGATIONS

DESCRIPTION OF METHODS

Lime sulphur solution, Bordeaux 4–4–50 mixture, and Burgundy 3–3⅝–50 mixture [3] are so commonly used that no discussion as to the methods of preparation is necessary. During the spraying experiments it seemed desirable to attempt to render the copper more readily available for action against the canker organism, following the theory [4] of Bedford and Pickering; (1, 2) in the case of Bordeaux mixture the excess of lime was, therefore, reduced to just the amount sufficient entirely to precipitate all of the copper. This was called neutral Bordeaux mixture. A similar neutral Burgundy mixture was employed in which the sodium carbonate added was just sufficient to precipitate the copper with no excess remaining. Ammoniacal copper carbonate solution, when used, was made up to contain: Copper carbonate, 5 ounces; concentrated ammonium hydroxide, 3 pints; and water, 50 gallons. The methods of preparation are, of course, well known. Formalin as a preventive was used as a simple solution, easy to prepare; neutral lead arsenate is also so commonly used as to need no discussion.

Two different oil-emulsion preparations were used in checking scale-insect increases following the fungicide applications. An oil emulsion described by Yothers(22) was commonly used. This consisted of soft soap, 4 pounds; paraffin oil (25° Baumé), 1 gallon; and water, 1 gallon. The preparation was made up in the ratio of 1 gallon of the mixture to 50 gallons of water. Another oil emulsion consisted of a mixture of a cresylic soap liquor with kerosene or distillate. This emulsion was prepared

[3] The spraying experiments reported here were begun and carried to a conclusion before the work upon the phenol coefficients of fungicides(11) with the canker organism had been completed.

[4] These references have not been available in Manila but are quoted from their reviews.

as follows: *Liquor cresolis compositus*, 1 quart; kerosene, 3 quarts; and water, to make 50 gallons.

A sticker was used in many instances in an attempt to cause the copper sprays and lime sulphur to adhere to the foliage for the greatest length of time possible. This sticker consisted of 2 pounds of resin, dissolved with heat in a solution of 1 pound of sodium carbonate in 1 gallon of water. The sticker was used in these experiments in the ratio of 1 quart of the mixture to 50 gallons of the spray mixture.

The removal of the sources of canker infection was obtained in some cases by pruning out twig and limb cankers. Another, somewhat drastic method was used in a few cases of trees with heavy foliage infections. A solution of formalin was prepared which would partially burn the citrus foliage; leaves with canker infections were sometimes already weakened, and these dropped after such a drastic spray, while normal leaves in many cases would survive this treatment. A 1 to 80 formalin solution was used for this purpose on sweet orange, grapefruit, and mandarin orange trees with some degree of success. Such a concentration was, however, too strong for lime and lemon trees, and almost complete defoliation would follow on those hosts. The use of formalin solutions for this procedure was closely related to the sunlight conditions; on rainy days or toward nightfall the formalin would not evaporate as rapidly as in direct sunlight and greater injury would result. The use of a spray solution for this purpose was called a clean-up spray, in contradistinction to the term preventive spray.

It was also attempted to secure the growth of new foliage during climatic seasons unfavorable to the development or dissemination of citrus canker. Such growth was secured by employing the pruning procedures at the end of the rainy season so that new growth stimulated by the pruning came out in the dry season. Maintenance of foliage growth was also secured in the dry season by irrigation.

The test of spray mixtures was made along two lines; namely, in connection with the pruning and the stimulation of growth measures, at Lamao, Bataan, Philippine Islands; and the efficacy of spraying alone, without pruning or other measures, was tested at Los Baños, Laguna, Philippine Islands.

THE SPRAYING EXPERIMENTS AT LOS BAÑOS

DESCRIPTION OF ORCHARD CONDITIONS

The orchard at Los Baños is maintained by the College of Agriculture of the University of the Philippines and consists of

rows of native sweet oranges, calamondins, lemons, Kusaie limes, citrons, and pummelos. With the exception of the Kusaie limes, these trees are largly native to the Philippines, without classification into horticultural varieties. The trees were, for the most part, five years old at the beginning of the experiment, and although varying considerably in size were commonly 3 to 5 meters in height and, with a few exceptions, in good growing condition. The trees were in orchard formation upon level land, protected but partially from the strong and sometimes violent winds. The orchard was clean cultivated at all times of the year; no irrigation was practiced during the dry season.

The orchard was divided into six plats, so arranged that each plat cut across the rows of similar species at right angles; each species was thus represented in each plat. It may seem unfortunate that the experiments were not carried on in orchards of a single uniform susceptible species, having plats consisting of but one variety; however, this was impossible in as much as no such mature orchard existed at that time in the Philippines.

The use of the specific name *Citrus maxima* (*C. grandis, C. decumana*) as pointed out by Merrill(15) has been followed in this paper.

PLAT I, AT LOS BAÑOS

The treatment of this plat consisted of an application of lime sulphur (32° Baumé) in a 1 to 40 solution. It was found that lime sulphur washed off very easily during the heavy rains at Los Baños.[5] In as much as the rains are normally very heavy in the wet season in Los Baños, it was apparent that lime sulphur could not be used against canker in this locality and its use on this plat was, therefore, abandoned.

PLAT II, AT LOS BAÑOS

Plat II consisted of two rows running parallel with rows of Plats I, III, IV, V, VI, and was left entirely untreated as a check upon the rows that were treated. The amounts of canker

[5] In this connection various methods were attempted to cause lime sulphur to adhere to the foliage for a longer period. Powdered casein in the ratio of 4 ounces to 50 gallons was sifted into the solution; compared with an application of lime sulphur without casein, made at the same time, no advantage was gained. Casein in the form of condensed milk was added to lime sulphur and similarly gave no advantage. The resin salsoda sticker was added in the ratio of 1 quart to 50 gallons of the lime sulphur. This mixture was applied to a plat of trees while at the same time lime sulphur with no such sticker was applied to a similar plat of trees. The foliage of both plats tested for sulphur at the end of two weeks was entirely negative.

on each tree in August, 1917, at the beginning of the experiments, and in August, 1918, when the experiments were completed, are shown in Table 5.

TABLE 5.—*Showing degree of canker affection of trees in untreated plat, Plat II, of the College of Agriculture citrus planting at Los Baños.*[a]

Species.	Leaves affected.			
	August, 1917.		August, 1918.	
	Per cent.	*Number.*	*Per cent.*	*Number.*
Citrus maxima	20		50	
Do	95		(b)	(b)
Do	0	0		8
Citrus sinensis	5		2	
Do	3		1	
Do	5		1	
Do	0	0	1	
Citrus mitis		10		10
Do		2		5
Citrus limonia	1		1	
Do	5		5	
Do	5		5	
Do	2		1	
Do	1		1	
Do	2			10
Citrus hystrix	0	0	0	0
Citrus aurantifolia	1		5	
Do	2		5	
Do	1		(b)	(b)
Do	2		10	
Citrus medica		10		5
Do		7		4
Do	0	0		9
Do		7		11
Do	1			15
Citrus maxima	65		10	
Do	50		100	
Citrus nobilis	0	0	0	0
Citrus maxima	5		1	
Citrus hystrix		6	1	
Citrus maxima	25		1	
Do	20		1	
Do	3		50	
Citrus species	40		5	
Citrus limonia	0	0	1	
Do	0	0	0	0
Citrus sinensis		28		9
Do		18		5

[a] The determination of the species mentioned in this and subsequent tables is taken from a chart of the college orchard at Los Baños made available through the kindness of Mr. Mariano G. Medalla, instructor in the College of Agriculture, University of the Philippines. The measurement of the amount of canker on the leaves at Los Baños in August, 1918, is also largely to be credited to Mr. Medalla. For this and for much other assistance the writer wishes to express his sincere thanks to Mr. Medalla.

[b] Dead.

It can be seen from this tabulation, that the amount of canker in this plat at the end of the experiment in August, 1918, was quite as great as it was in August, 1917, when the work was undertaken. The criticism may be raised that the estimation of the amounts of foliage cankered could not be accurate. This is, of course, a valid criticism, but no other method of measuring the amounts of canker was available in as much as few or no fruits were formed in the orchard during this season. The amounts of canker were determined only after long and careful examination and, in the case of the affected leaves expressed numerically, is from actual count.

PLAT III, AT LOS BAÑOS

The treatment of this plat was as follows:

August 24, 1917. Cresol-kerosene emulsion, plus mercuric bichloride to make a 1 to 1,500 solution.
September 14, 1917. Burgundy 3-3⅝-50 mixture.
October 11, 1917. Burgundy 3-3⅝-50 mixture.
November 12, 1917. Burgundy 3-3⅝-50 mixture, plus powdered neutral lead arsenate to make a 1-50 mixture.
December 20, 1917. Burgundy 3-3-50 mixture.
January 5, 1918. Yothers's oil emulsion.
May 17, 1918. Neutral Burgundy mixture, plus formalin 1-100.
June 14, 1918. Neutral Burgundy mixture, plus formalin 1-100 and cresol-kerosene emulsion.
July 13, 1918. Neutral Burgundy mixture.

TABLE 6.—*Showing degree of canker affection of trees in Plat III of the College of Agriculture citrus planting at Los Baños.*

Species.	Leaves affected.			
	August, 1917.		August, 1918.	
	Per cent.	*Number.*	*Per cent.*	*Number.*
Citrus maxima	3		0	0
Do	1			1
Do	10		1	
Citrus sinensis	10			2
Do	8		0	0
Do	1		0	0
Do	0	0	0	0
Do	10			12
Do	0	0		4
Do	20		0	0
Do	5		0	0
Citrus mitis	0	0	0	0
Do	0	0	0	0
Do		2	0	0
Do		5	0	0
Citrus limonia	5		2	
Do	1			10

TABLE 6.—*Showing degree of canker affection of trees in Plat III of the College of Agriculture citrus planting at Los Baños*—Continued.

Species.	Leaves affected.			
	August, 1917.		August, 1918.	
Citrus limonia—Continued.	*Per cent.*	*Number.*	*Per cent.*	*Number.*
Do	5			5
Do	5		0	0
Do	2		0	0
Do	2		0	0
Do	2			5
Do	1			4
Do		20		2
Do		20	0	0
Do		30		9
Do		25		5
Citrus hystrix	0	0	0	0
Do	0	0	0	0
Do	0	0	0	0
Do		8	0	0
Citrus aurantifolia	3		0	0
Do	2		0	0
Do	1		0	0
Do	3		0	0
Do	2			16
Do	1			25
Do	2		1	
Do	1			11
Citrus medica	0	0		6
Do	0	0	0	0
Do		4	0	0
Do	0	0	0	0
Citrus maxima	40		0	0
Do	50			9
Do	50		1	
Do	50		1	
Do	0	0	0	0
Citrus medica	0	0	0	0
Citrus hystrix	2			8
Do	5			17
Do	40			11
Do		5	1	
Citrus maxima	25			25
Do	2			4
Do	5			27
Do	0	0		7
Do	34		0	0
Do	5			3
Do	30		0	0
Do	3			5
Do	2			27
Do	2			7
Citrus limonia		5	0	0
Do	0	0	0	0
Do	0	0	0	0

Cresol-kerosene emulsion plus mercuric bichloride 1 to 1,500 was used as an insecticide at the beginning of the experiment, to check the increase of scale insects. It was found that the addition of bichloride to make a 1 to 1,500 solution was much too strong a mixture, and defoliation of many of the normal as well as cankered leaves resulted. The neutral Burgundy mixture was employed under greatly varying weather conditions; upon the citrus trees no evidence of burning of the foliage or fruit was ever observed in these experiments.

The foregoing tabulation shows that a reduction in the amounts of citrus canker was obtained in this plat. The most noteworthy cases are those of the Kusaie limes and the trees of *Citrus limonia*, both of which species were reduced from a condition of fairly general infection to a condition of fairly satisfactory control.

PLAT IV, AT LOS BAÑOS

The treatment of this plat was as follows:

August 24, 1917. Bordeaux 4–4–50 mixture plus sugar (sugar, 15 per cent by weight of the copper sulphate in the mixture) and plus 1 quart of resin, sal-soda sticker.

September 13, 1917. Bordeaux 4–4–50 mixture plus sugar (sugar, 15 per cent by weight of the copper sulphate in the mixture) and plus 1 quart of resin, sal-soda sticker.

October 11, 1917. Bordeaux 4–4–50 mixture plus sugar (sugar, 15 per cent by weight of the copper sulphate in the mixture) and plus 1.25 quarts of resin, sal-soda sticker.

November 12, 1917. Bordeaux 4–4–50 mixture plus sugar (sugar, 15 per cent by weight of the copper sulphate in the mixture) and plus 1.25 quarts of resin, sal-soda sticker. To this was also added for this application powdered, neutral, lead arsenate to make a 1–50 mixture.

December 20, 1917. Neutral Bordeaux mixture.

January 3, 1918. Yothers's oil emulsion.

May 16, 1918. Neutral Bordeaux mixture plus formalin 1–100.

June 14, 1918. Neutral Bordeaux mixture plus formalin 1–100 and cresol-kerosene emulsion.

July 13, 1918. Neutral Bordeaux mixture.

The use of sugar in Bordeaux mixture is described by Bourcart(3) as having been first suggested by Perret. It was said to make the copper more easily available and to cause the Bordeaux to adhere better to the foliage. Lutman(13) states that the addition of sugar to the lime before preparing Bordeaux mixture also weakens the precipitation membranes, causing the precipitation to go more nearly to completion and increasing the covering power of the mixture.

TABLE 7.—*Degree of canker affection of trees in Plat IV of the College of Agriculture citrus planting at Los Baños.*

Species.	Leaves affected.			
	August, 1917.		August, 1918.	
	Per cent.	*Number.*	*Per cent.*	*Number.*
Citrus maxima	50			
Do	50			
Do	25		2	
Do	1		0	0
Citrus sinensis	1		0	0
Do	2		0	0
Do	20			1
Do	20		0	0
Do	2			
Do	5			1
Do	15			6
Citrus mitis		3	0	0
Do		4	0	0
Do	0	0	0	0
Do		10	0	0
Citrus limonia	15			4
Do	10			2
Do	5		0	0
Do	5		0	0
Do	2		0	0
Do	1			5
Do	5		0	0
Do	5			5
Do	1		0	0
Do	2		0	0
Do	2		0	0
Do	1			3
Citrus hystrix	0	0	0	0
Do	0	0	0	0
Do	0	0	0	0
Do	5		0	0
Citrus aurantifolia	2		0	0
Do	2		0	0
Do	1		0	0
Do		20	(a)	(a)
Do	2			6
Do	3			15
Do	2			9
Do	2			35
Citrus medica	25		1	
Do	50		1	
Do	25		1	
Do	25		2	
Citrus maxima	50		5	
Do		15		6
Do	50		5	
Do	50		5	
Do	0	0	0	0

[a] Dead.

TABLE 7.—*Degree of canker affection of trees in Plat IV of the College of Agriculture citrus planting at Los Baños*—Continued.

Species.	Leaves affected.			
	August, 1917.		August, 1918.	
	Per cent.	*Number.*	*Per cent.*	*Number.*
Citrus hystrix	40			10
Do	50		1	
Do	40		1	
Citrus maxima	50		25	
Do	5			16
Do	1			5
Do	2			21
Do	2			18

It is apparent that some reduction in the amounts of canker infection was accomplished in the foregoing plats.

PLAT V, AT LOS BAÑOS

The trees in this plat were of the same species and varieties as those represented in Plats I, II, III, and IV. This plat was left entirely untreated, as a check upon the sprayed plats.

TABLE 8.—*Degree of canker affection of untreated trees in Plat V, of the College of Agriculture citrus planting at Los Baños.*

Species.	Leaves affected.			
	August, 1917.		August, 1918.	
	Per cent.	*Number.*	*Per cent.*	*Number.*
Citrus maxima	25			40
Do	20		2	
Do	20			1
Do	25			37
Citrus mitis	0	0	0	0
Do	0	0	0	0
Citrus limonia	5		5	
Do	5		5	
Do		22		10
Do	5			37
Do	1		1	
Do	1		1	
Do		12	0	0
Citrus hystrix		10	0	0
Citrus aurantifolia	5			5
Do	5			20
Do	2		2	
Do	1		0	0
Citrus maxima	50			21
Do	1		1	

Table 8 shows that in this plat canker, even though untreated, decreased to some extent from what it was at the beginning of the experiment. Although there are possible explanations for this they will not be entered into in detail here; granted that seasonal differences permitted some reduction in canker, it is apparent that considerably more reduction was obtained on the sprayed plats.

PLAT VI, AT LOS BAÑOS

It was intended to run this plat entirely as a test of formalin against citrus canker. It became evident a few weeks after the first application, however, that new infections were appearing and that applications of formalin as a preventive would be necessary much too often to be feasible. The spraying with formalin solution was therefore abandoned as a preventive but was subsequently used on other plats for clean-up work.

DISCUSSION OF RESULTS AT LOS BAÑOS

The comparative value of the sprays which were tried is briefly summarized as follows: Cankers recurred after the application of formalin 1 to 100 without any reduction in number or distribution; the results at Los Baños are therefore taken to indicate that formalin has little value as a preventive spray. In the heavy tropical rains in the Philippines lime sulphur did not adhere well to the foliage, although it is possible that in regions of more moderate rainfall lime sulphur would be of great value. Burgundy and Bordeaux mixtures, when freshly prepared, adhered to the foliage very well and no difficulty was experienced with the washing of such copper sprays from the foliage. The determination of the length of the periods between spraying depended, therefore, chiefly upon the amount of new growth which came out and was unprotected by coatings of spray. As to the comparative merits of Burgundy and Bordeaux mixtures as preventives, little or no difference showed in the results.

From Tables 6 and 7, showing the results of plats sprayed with Burgundy and Bordeaux mixtures, it is apparent that the amounts of citrus canker in most cases were reduced to some extent; Table 5, showing an untreated plat, shows no decrease in canker; Table 8, also untreated, destroys some of the value of the results on the treated plats, since it also in some cases shows a decrease in the amount of canker affection. There are possible explanations for this; but, regardless of such explanations, it is apparent that the reduction in the amounts of canker in the treated plats is greater than in either of the untreated plats.

It would seem, then, that such preventive sprays have, to some extent, reduced the amounts of infection. In the light of the writer's disinfectant tests(11) it is difficult to ascribe the cause for this reduction unless it be to the excesses of copper precipitants applied, or even possibly to the mechanical effects of the spray deposits on the foliage.

The criticism of the results, from a commercial viewpoint, would be of course that nine spray applications are not economically feasible. It should be noted however that, theoretically, control should more nearly approach the absolute, year after year, since with the gradual prevention of canker infection by preventive coatings there is also a gradual reduction in the sources of infection. This would reduce to some extent the necessity for such frequent spray applications. It would seem probable also that, with greater knowledge of the climatic peculiarities of the locality and the growth periods of the different varieties, the number of spray applications would be reduced somewhat. This can only be determined by a continuation of the experiments, which will be reported upon in further publications.

THE CONTROL EXPERIMENTS AT LAMAO

DESCRIPTION OF ORCHARD CONDITIONS

In these experiments no effort was made to compare the value of the different spray mixtures used, the main purpose being to determine whether or not canker control was feasible by any and all means. The experiments were carried on in three orchards of the Lamao experiment station of the Philippine Bureau of Agriculture. These orchards consist of collections of the common horticultural varieties of *Citrus* species grown in the United States and Japan, usually two individuals representing each variety.[6]

The division of these orchards into spray plats in such a way as to include individuals of each species in each plat was difficult; however, an attempt was made to make each plat representative.

[6] These collections are mainly the work of Mr. P. J. Wester, agricultural advisor, Philippine Bureau of Agriculture. The collections are very extensive and contain a great number of the commonly grown citrus varieties of America as well as many Japanese-grown varieties. In addition, Mr. Wester has introductions from India, Siam, China, and Australia, as well as a very extensive collection of the native Philippine fruits. The writer is greatly indebted to Mr. Wester for his very hearty coöperation in the identification of obscure varieties, the use of his card indexes, and all matter relating to his collections.

It is unfortunate that plats of uniformly susceptible varieties could not be employed; but, as stated previously, there were no such mature orchards in the Philippines.

The trees, except in a few instances, were in good growing condition, planted in orchard formation on level, clean-cultivated land. The trees were for the most part five years old at the beginning of the experiment. The orchards were surrounded by dense thickets of bamboo, 10 to 14 meters high, and these bamboo thickets formed very efficient windbreaks.

All plats at Lamao underwent entirely the same treatment in regard to irrigation, fertilization, and cultural operations. Only treated plats underwent pruning, and no pruning of the control plats was made.

All spraying mentioned here was carried on with a hand-power pump equipped with a pressure tank, and all spray applications were made with the pressure maintained at from 120 to 140 pounds. Operations for the removal of infected parts and the stimulation of new growth were identical in all the treated plats.

The detailed reports will not be presented from all of the plats, in as much as the general conclusions from each plat were much the same. Several of the plats, however, contained varieties, the susceptibility and resistance of which may be of interest in America; these plats have been selected for presentation not only to show the effect of the canker-control methods but also to show comparative susceptibility.

PLAT I, ORCHARD A, LAMAO

September 3, 1917. Lime sulphur (32° Baumé) 1–40 solution.
September 20, 1917. Bordeaux 4–4–50 mixture.
September 21, 1917. Trees pruned for twig cankers.
October 23, 1917. Bordeaux 4–4–50 mixture.
November 20, 1917. Formalin 1–80 solution.
November 21, 1917. Trees pruned for twig cankers.
November 28, 1917. Lime sulphur 1–50 solution plus formalin 1–100, and powdered, neutral lead arsenate to make 1–50 mixture.
December 7, 1917. Kerosene-lysol emulsion, plus formalin 1–70.
January 10, 1918. Neutral Bordeaux mixture plus resin, sal-soda sticker and formalin 1–100. Trees carefully pruned for twig cankers.
May 31, 1918. Lime sulphur 1–40 solution.
June 25, 1918. Neutral Bordeaux mixture plus kerosene-lysol emulsion, plus formalin 1–100.
August 1, 1918. Lime sulphur 1–35 solution.

The condition of the trees in regard to canker may be followed through the different seasons in Table 9.

Work on this plat was begun by spraying with lime sulphur, but it became apparent, as at Los Baños, that the lime-sulphur solution was easily washed from the leaves by the beating, driving rains. Thereafter a change was made to Bordeaux mixture, except in seasons when the rainfall was less intense. In such seasons of less rainfall, because of the increase of scale insects following the successive use of copper sprays, lime sulphur was used whenever possible for its action as a scalecide as well as for its action against canker.

PLAT II, ORCHARD A, LAMAO

This plat consisted of three rows of trees adjacent to the rows of Plat I; the character of the trees and degree of canker infection throughout the season are shown in Table 10. All trees in this plat were left entirely untreated. Unfortunately these trees are for the most part varieties different from those that appear in the sprayed plats; nevertheless, they may afford some basis for comparison between the treated and the untreated plats.

Although some of the trees in this untreated plat show reductions in the amount of canker infection, some show increases. As a whole, then, this plat, serving as a control, can be used as a basis for comparison with the treated plats. The trees being untreated also afford something of an idea of the susceptibility of the species represented in this plat.

PLAT III, ORCHARD A, LAMAO

This plat consisted of three rows of trees, the character of which is shown in the tabulation of the degree of canker infection during the various stages of control experiments. The treatment of the plat was as follows:

September 1, 1917. Lime sulphur 1–40 solution.
September 20, 1917. 4–4–50 Bordeaux mixture. Trees pruned for twig cankers.
October 23, 1917. 4–4–50 Bordeaux mixture.
November 20, 1917. Formalin 1–80 solution as a clean-up spray.
November 28, 1917. Formalin 1–100 solution plus powdered, neutral, lead arsenate to make 1–50 mixture.
December 6, 1917. Lime sulphur 1–40 solution plus formalin 1–80.
January 9, 1918. Neutral Bordeaux mixture plus formalin 1–100 and Yothers's oil emulsion. Trees pruned for twig cankers.
May 31, 1918. Lime sulphur 1–30 solution.
June 24, 1918. Lime sulphur 1–35 solution plus formalin 1–100.
August 1, 1918. Lime sulphur 1–35 solution plus resin, sal-soda sticker.

The complete reversal from Bordeaux mixture to lime-sulphur solution in 1918 was necessitated by severe attacks of scale insects following the Bordeaux applications.

TABLE 9.—*Canker condition of the citrus trees in Plat I, Orchard A, Lamao, at the different seasons.*[a]

Variety.	Species.	Leaves affected.									
		September 1, 1917.		October 30, 1917.		January 12, 1918.		May 25, 1918.		August 1, 1918.	
		Per cent.	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*
Valencia	*Citrus sinensis*		1	0	0	0	0	0	0	0	0
Do	do		11		6	0	0		1	0	0
Tizon	*Citrus nobilis*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Ruby	*Citrus sinensis*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Valencia	do	0	0	0	0	0	0	0	0	0	0
Do	do		5	50			1	0	0	0	0
Ladu	*Citrus nobilis*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Native orange	*Citrus sinensis*	50			7	0	0	0	0	0	0
Messina	*Citrus limonia*	30			1	0	0	(b)	(b)		
Murrill orange	*Citrus* species	100		10		2			56		(c)
Do	do	50		10		2			10	0	0
Native fruit	*Citrus excelsa*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Sampson	*Citrus* hybrid-tangelo	100		15			2	0	0	0	0
Do	do	100			8		1	(b)	(b)		
Rough lemon	*Citrus limonia*	0	0	0	0	0	0	0	0	0	0
Seedless pummelo	*Citrus maxima*	10		10			10	0	0	0	0
Do	do	50		10			20	0	0	0	0
White seedless pummelo	do	100		5			1	0	0	0	0
Do	do	50		50			15		1	0	0
Cabuyao	*Citrus hystrix*		1	50		50		2		1	
Do	do		11	50		25		5		1	
Oblong pummelo	*Citrus maxima*	100			23		7	0	0	0	0

West Indian lime	*Citrus aurantifolia*	100		25		10		5		1					
Do	do	100		15		10		5		1					
Do	do	100		10		10		5		1					
Chinese lime	*Citrus limonia*	100		90		10		1		0	0				
Do	do	100		75		5		2		1					
Native cajel	*Citrus sinensis*	30		5			11		1	0	0				
Do	do	100		10		10		0	0	0	0				
Ellen	*Citrus maxima*	100		5		5			10	0	0				
Do	do	100		20		20			7	0	0				
Washington navel	*Citrus sinensis*	100		0	0	0	0	(b)	(b)						
Pernambuco	*Citrus maxima*	100		60		50		10		1					
Do	do	100		25			20	0	0	0	0				

[a] At the beginning of the work an attempt was made to get an actual count of infected leaves upon each tree; this, of course, moved very slowly and was necessarily abandoned. However, the initial work in counting afforded an excellent basis for the later estimates of the percentages of leaves affected as entered in this and following tables. The estimates were in each case made after detailed examination; the statement "0" is an exact observation.

[b] Dead.

[c] Five twigs cankered.

TABLE 10.—*Canker condition of the untreated citrus trees of Plat II, Orchard A, Lamao, at the different seasons.*

Variety.	Species.	Leaves affected.									
		September 1, 1917.		October 30, 1917.		January 12, 1918.		May 25, 1918.		August 1, 1918.	
		Per cent.	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*
Sampson	*Citrus* hybrid tangelo	100		50		50		25		25	
Do	do	100		50		60		15		15	
Marsh	*Citrus maxima*	100		80		80		50		25	
Do	do	100		80		80		50		80	
Triumph	do	100		60		50		25		90	
Do	do	100		25		25		10		75	
Pink pummelo	do		6		10		11	5		0	0
Do	do	100		100		15			10	0	0
Lemon variety	*Citrus limonia*	0	0		4	(a)	(a)	0	0	0	0
Do	do	0	0	0	0	0	0	(b)	(b)		
Pineapple	*Citrus sinensis*	50		50		50		15		50	
Do	do	80		10		10		5		5	
Washington navel	do	20		5		5		5		10	
Do	do	1		1		1		2		50	
Jaffa	do		13	50		10		20		30	
Do	do	0	0	25		5		5		5	
Mandarin	*Citrus nobilis*		5		6		2		6	0	0
Do	do	0	0	0	0	0	0	0	0	0	0

[a] Cankered fruit.

[b] Dead.

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Table 11 shows that in all cases of susceptible trees, a considerable reduction in the amounts of citrus canker took place during the year.

The behavior of the trees of the Tahiti lime is noteworthy. Both of these trees were in actively growing condition and well exposed to infection; however, they exhibited a very moderate susceptibility to canker, and control was very easily obtained. Other trees of the Tahiti lime have been under observation at Lamao and have exhibited the same slight susceptibility to canker. This is all the more peculiar, as Wester(19) also has pointed out, since for the most part lime varieties are extremely susceptible.

The behavior of the Triumph grapefruit is also noteworthy; as grown at Lamao, it apparently has a less degree of susceptibility to canker than have the other American-grown grapefruit varieties. The lemon varieties as shown in the table are but moderately susceptible and they responded readily to the control methods employed.

PLAT IV, ORCHARD A, LAMAO

The treatment and results were much the same on this plat as on plats I and III.

Of interest from this plat was the ease of control of the Limon Real, a Philippine, lemonlike fruit. Of greater interest in the United States is the behavior of the Mediterranean sweet orange varieties, the Jaffa, St. Michael, and Ruby. The susceptibility of these varieties is very slight, and they responded very quickly to the control methods employed.

PLAT VI, ORCHARD B, LAMAO

It was intended that this plat should be sprayed continuously with ammoniacal copper carbonate solution as a test of that spray as compared with other mixtures.

At the beginning of October, after two applications, it was apparent that this spray was having little effect upon citrus canker, in as much as new infections were appearing continuously. Spraying was abandoned, therefore, and the plat became a check upon the other plats in Orchard B, for the next spraying season.

Table 12 shows that on a few trees in this plat the amounts of canker decreased; on the other hand, there was an equal number of cases where the amounts of canker increased. Examination of the table enables one to compare the canker condi-

TABLE 11.—*Canker condition of the trees in Plat III, Orchard A, Lamao, at various seasons of the year.*

Variety.	Species.	Leaves affected.									
		September 1, 1917.		October 30, 1917.		January 14, 1918.		May 28, 1918.		August 2, 1918.	
		Per cent.	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*
Japanese orange*	*Citrus aurantium*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Ruby	*Citrus sinensis*	0	0	.....	2	0	0	.....	4	0	0
Do	do	.....	9	0	0	0	0	.....	6	0	0
Clarke	*Citrus limonia*	.....	2	.....	1	0	0	.....	1	0	0
Do	do	0	0	0	0	.....	3	0	0	0	0
Holdfast	*Citrus sinensis*	10	.....	10	.....	5	.....	.....	2	0	0
Do	do	1	.....	1	.....	0	0	0	0	0	0
Villa Franca	*Citrus limonia*	1	.....	1	.....	1	.....	0	0	0	0
Do	do	0	0	0	0	.....	6	.....	2	0	0
Lisbon	do	0	0	0	0	0	0	0	0	0	0
Bengal	do	0	0	0	0	0	0	0	0	0	0
Mediterranean	*Citrus sinensis*	50	.....	.....	11	.....	7	.....	1	0	0
Do	do	20	.....	1	.....	.....	14	.....	6	0	0
Valencia	do	1	.....	1	.....	.....	80	.....	6	.....	1
Do	do	1	.....	.....	6	.....	13	.....	2	0	0
Marsh	*Citrus maxima*	100	.....	5	.....	20	.....	40	.....	30	.....
Do	do	100	.....	5	.....	5	.....	10	.....	20	.....
Tahiti	*Citrus aurantifolia*	50	.....	50	.....	.....	2	.....	3	0	0
Do	do	.....	1	.....	3	0	0	0	0	0	0
Sicily	*Citrus limonia*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Washington navel	*Citrus sinensis*	.....	2	.....	6	0	0	0	0	0	0
Do	do	.....	1	0	0	0	0	0	0	0	0
Thornless	*Citrus limonia*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	.....	2	0	0	0	0	0	0

Triumph	*Citrus maxima*	80		15			5		13	0	0
Do	do	50		5			2	0	0	0	0
Larrantta	*Citrus sinensis*	50		50		1			15	0	0
White Silletta	do	50		50		1			7	0	0
Do	do	50		10		1			8		4
Citron	*Citrus medica*	1			2	0	0	0	0	0	0
Do	do	50		0	0	0	0	0	0	0	0
Calamondin	*Citrus mitis*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Jaffa	*Citrus sinensis*		12	1			10		3	0	0
Do	do		10		1		5		1	0	0
Bahia	do	0	0	0	0		5	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0

[a] According to Doctor Tanaka, a specialist on Japanese citrus fruits, residing at Nishi Suma, Hyogo Ken, Japan, this "Japanese orange" is identical with the Japanese-grown *Daidai*, a form of *Citrus aurantium*.

TABLE 12.—*Degree of canker affection of the trees in Plat VI, Orchard B, Lamao, at various seasons of the year.*

Variety.	Species.	Leaves affected.									
		September 1, 1917.		October 31, 1917.		January 18, 1918.		May 29, 1918.		August 1, 1918.	
		Per cent.	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*
Sampson	*Citrus* hybrid tangelo	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	1	0	0	0
Colo colo	*Citrus hystrix*	50	0	50		25		30		50	
Do	do	50	0	50		50		50		90	
Calamondin	*Citrus mitis*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Sour orange	*Citrus aurantium*	35		35			7		2		1
Native fruit	*Citrus pseudolimonum*	80		80		40		50		80	
Do	do	50		50		50		10		100	
Sour orange	*Citrus aurantium*		1		8		10		2	0	0
Do	do		1	0	0	0	0	0	0		3
Native orange	*Citrus sinensis*		2	1		0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Valencia	do		12	50		25			20	30	
Do	do		8	50		10			2	(*)	(*)
Cabuyao	*Citrus hystrix*		2	0	0		3		3		2
Do	do	0	0	0	0	0	0	0	0	0	0
Citron	*Citrus medica*	80		50		50		50		90	
Szinkom	*Citrus nobilis*		2	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Sour orange	*Citrus aurantium*		4	0	0	0	0	0	0	0	0
Do	do	50		5		1			10		2
Pineapple	*Citrus sinensis*	80		80		10		20		80	
Do	do	50		50		10		5		10	
King	*Citrus nobilis*	0	0	0	0		2	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0

Native fruit	*Citrus maxima*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Majorca	*Citrus sinensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Do	do	0	1	0	1	0	2	0	2	0	1	0	1	0	1	0	1	0	1	0	1
Maltese	do	25	0	25	0	0	4	0	3	0	2	0	2	0	2	0	2	0	2	0	2
McCarty	*Citrus maxima*	100	0	100	0	90	0	50	0	100	0	100	0	100	0	100	0	100	0	100	0
Everbearing	*Citrus sinensis*	25	0	25	0	25	0	10	0	10	0	10	0	10	0	10	0	10	0	10	0
Siamese	*Citrus maxima*	75	0	75	0	0	7	0	2	0	3	0	3	0	3	0	3	0	3	0	3
Do	do	0	2	0	2	0	2	0	11	0	0	0	0	0	0	0	0	0	0	0	0
Suntara	*Citrus nobilis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cabuyao	*Citrus hystrix*	10	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Do	do	25	0	40	0	(a)	(a)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Du Roi	*Citrus sinensis*	0	0	0	0	0	0	(a)	(a)	0	0	0	0	0	0	0	0	0	0	0	0
Native orange	do	80	0	80	0	10	0	10	0	60	0	60	0	60	0	60	0	60	0	60	0
Do	do	40	0	40	0	1	0	10	0	75	0	75	0	75	0	75	0	75	0	75	0
Homosassa	do	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biasong	*Citrus micrantha*	1	0	25	0	10	0	10	0	50	0	50	0	50	0	50	0	50	0	50	0
Parson Brown	*Citrus sinensis*	40	0	40	0	0	6	0	8	0	0	0	0	0	0	0	0	0	0	0	0
Do	do	50	0	50	0	75	0	25	0	40	0	40	0	40	0	40	0	40	0	40	0
Pati China	*Citrus aurantifolia*	40	0	0	2	0	2	0	16	50	0	50	0	50	0	50	0	50	0	50	0

[a] Dead.

tion of the untreated trees with the amounts of canker of the other, treated plats.

The trees of this control plat also afford a fair idea of the susceptibility of the horticultural varieties represented. The Parson Brown, Homosassa, and Pineapple, sweet orange varieties of Florida origin, show a considerably greater susceptibility than do the Valencia, Majorca, Maltese, and Du Roi, which are Mediterranean varieties. The King, Suntara, and Szinkom, varieties of the mandarin orange, illustrate the almost entire freedom from canker of that class of hosts. The great susceptibility of the American-grown grapefruit varieties is illustrated by the trees of the McCarty variety in this plat.

PLAT VII, ORCHARD B, LAMAO

The rows of trees of this plat paralleled and were contiguous to those in Plat VI; treatment was as follows:

September 4, 1917. Cresol 1–80 solution.
September 20, 1917. Trees pruned for citrus canker.
September 22, 1917. Lime sulphur 1–40 solution plus formalin 1–80.
October 22, 1917. 3–3–50 Burgundy mixture plus resin, sal-soda sticker.
November 21, 1917. Formalin 1–80 solution plus powdered, neutral, lead arsenate to make a 1–50 mixture.
December 1, 1917. Formalin 1–80 solution plus powdered, neutral, lead arsenate to make a 1–50 mixture.
December 4, 1917. Trees pruned for twig cankers.
December 7, 1917. Lime sulphur 1–40 solution plus formalin 1–100.
January 10, 1918. 3–3–50 Burgundy mixture plus Yothers's oil emulsion.
January 17, 1918. Trees pruned for twig cankers.
June 1, 1918. Lime sulphur (25° Baumé) 1–30 solution.
June 26, 1918. 3–3–50 Burgundy mixture plus cresol-kerosene emulsion and formalin 1–100.
July 30, 1918. 3–3–50 Burgundy mixture plus cresol-kerosene emulsion.

Cresol solution was used at the beginning of the work as a clean-up spray; however, it had no value in this respect when used at a dilution of 1–80 and its use was abandoned. In the succeeding spray applications, lime-sulphur solution was used at different times to check the increase of scale insects, but the plat was in the main sprayed with Burgundy mixture.

Table 13 indicates that citrus canker has been materially reduced in amount upon all affected varieties and species. As evidenced in the table, the difficulty of control of the Duncan, the Marsh, and the McCarty grapefruits and the Everglade and

the Trinidad limes is noteworthy. This can be compared with the relative freedom from canker and ease and quickness of control of the Mediterranean sweet orange varieties, the Du Roi and Hart's Late.

Plat VIII, in Orchard B, yielded much the same conclusion and need not be presented in detail here. In this plat the Paper Rind and the Maltese, varieties of the sweet orange, showed slight susceptibility and responded readily to the control measures. These varieties are of interest since they are usually also classed with the Mediterranean group of sweet-orange varieties.

DISCUSSION OF METHODS AND RESULTS AT LAMAO

From the foregoing it is apparent that canker has been reduced in the treated plats to a degree at which it may be said that a reasonable control has been obtained. Untreated plats have shown no reduction in canker. Of course, the number of spray applications must be considered, ten fungicide applications having been made on those plats and a considerable expenditure of labor incurred in pruning. Although such procedure would immediately appear prohibitive as an orchard practice, to arrive at the correct conclusion as to its feasibility consideration must be taken of the different citrus species as hosts, of the different degrees of their susceptibility and the bearing such susceptibility has upon the ease or difficulty of control, and of the cost of control. The spray applications and other methods used on these plats sufficed to decrease the amounts of canker, to a degree that could be considered a control, upon the most susceptible hosts, the lime and grapefruit varieties, as well as upon the more moderately susceptible hosts. Upon less susceptible hosts, such as the sweet orange, the lemon, and the mandarin orange, these control measures apparently could be much simplified and, consequently, of course be made cheaper.

The correct conclusion from these experiments would seem to be that control has been obtained, but that upon the grapefruit and limes such control is not economically feasible by the methods employed; upon the less susceptible hosts control has also been obtained, though the treatments applied apparently exceeded actual requirements for the efficient control of canker. Therefore, no conclusions as to the practicability of control upon such hosts can be drawn as yet. Further experiments are now in progress to make possible definite conclusions on the control of such moderately susceptible hosts.

TABLE 13.—*Degree of citrus canker affection of trees in Plat VII, Orchard B, Lamao, at various seasons of the year.*

Variety.	Species.	Leaves affected.									
		September 1, 1917.		October 31, 1917.		January 14, 1918.		May 29, 1918.		August 1, 1918.	
		Per cent.	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*
Duncan	*Citrus maxima*	50		50		35			44		4
Do	do	50		50			20		29	0	0
Pineapple	*Citrus sinensis*	50		10			2	0	0		11
Marsh	*Citrus maxima*	50		50		90			11		12
Enterprise	*Citrus sinensis*	50		50		0	0	0	0	0	0
Do	do	0	0		20	0	0	0	0	0	0
Hart's late	do	0	0	0	0	0	0	0	0	0	0
Do	do	20			3		7	0	0	0	0
Saagkam	*Citrus nobilis*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Native fruit	*Citrus madurensis*	25		5			10	0	0	0	0
Do	do	75		75		10		0	0	0	0
Native orange	*Citrus aurantium*	0	0		10	0	0	0	0	0	0
Do	do		10		1		1	0	0	0	0
Native fruit	*Citrus maxima*	0	0		10		8	0	0	0	0
Do	do		4		30		50		1	0	0
Du Roi	*Citrus sinensis*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
McCarty	*Citrus maxima*	50		50			12		2	0	0
Do	do	25		50			100	0	0	0	0
Le Nestour	*Citrus medica*	25		10		0	0	0	0	0	0
Do	do	75		10			1	0	0	0	0
Native fruit	*Citrus maxima*		9		2	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Cabuyao	*Citrus hystrix*	0	0	0	0	0	0	0	0	0	0
Do	do		6		5	0	0	0	0	0	0

Native orange	*Citrus sinensis*	50		50			25		3		2
Do	do	50		50			33	0	0	0	0
Trinidad	*Citrus aurantifolia*	40		40			12		30		1
Do	do	25		25		5			25	0	0
Tamisan	*Citrus longispina*	25		25			2	0	0		5
Do	do	40		40		0	0	0	0	0	0
Native fruit	*Citrus maxima*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0		0	0	0	0
Everglade	*Citrus aurantifolia*	80		80		5		5		10	
Do	do	50		50			10		15		15
Finger citron	*Citrus medica*	0	0	0	0	0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0	0	0
Canci	*Citrus hystrix*	50		50			1		1	0	0
Do	do	25		10		0	0	0	0	0	0
Parson Brown	*Citrus sinensis*	40		40		0	0	0	0		10
Do	do	25		5		0	0	0	0		1

The observations presented in the tables were supplemented by a less complete and thorough observation, made in October, when it was found that, although some slight increase in canker had taken place in the case of the grapefruit varieties, the varieties of sweet orange and less susceptible species had maintained their comparative freedom from canker. The control obtained, therefore, cannot be criticized as having been secured during seasons unfavorable to the activities of the citrus-canker organism, although advantage was taken of such an unfavorable period (the dry season, December to May), to minimize the dangers of reinfection during favorable periods (the wet season, June to November). Such control as was obtained, in other words, was secured in the dry season and, except in the case of some of the grapefruit varieties, was maintained through the wet season, from June to October.

Preventive sprays.—As to the comparative value of the different spray mixtures as preventives, little can be concluded from the work at Lamao, because of the varied program for each plat. However, certain other factors developed which would eliminate or qualify the value of some of the mixtures. Thus copper sprays, if unaccompanied by scalecides, caused a great increase in scale insects; lime sulphur probably could be used in regions of less intense rains, and in such cases would be of the greatest value because of its additional function as a scalecide; formalin 1 to 100 apparently was of little or no value as a preventive.

The foregoing being the conclusions derived from the experiment, it also seems desirable to offer several suggestions for control procedures that became evident and that may be of value in future work.

Clean-up sprays.—In many cases of heavily infected trees, a spray of formalin 1 to 80 caused a large proportion of the previously weakened cankered leaves to drop; in other words, formalin 1 to 80 to some extent seemed to be successful as a selective, clean-up spray. On trees already well infected such a clean-up spray, followed by careful pruning out of canker, materially hastened control.

Stimulation of growth at climatic periods unfavorable for canker development.—Another more important point was the stimulation of new growth at periods in the year when the lack of moisture limited the activity of the canker organism. At Lamao such new growth was stimulated in the early part of

the dry season, with the result that such foliage matured and hardened during the dry season without incurring danger from reinfection. This matured foliage then entered the rainy season with the danger of infection very much minimized, and only in the case of the grapefruit and lime varieties was difficulty encountered in the infection of such foliage.

Control of insects to prevent dissemination of canker.—Along the edges of leaves where chewing insects have bitten, cankers are very often found (Plate 1). Cankers also often appear in definite trails following the work of leaf miners (Plate 2). This emphasized the need for thorough control of such insects, and the addition of lead arsenate to the spray mixtures was frequently made. In canker-control work on all varieties of *Citrus* species at Lamao, then, it has been evident that insect control is also an essential factor.

Windbreaks to aid in prevention of canker dissemination.—From field evidence it was apparent that another agent which contributes to the dissemination of citrus canker is the wind. This aid to canker development is due not alone to the spread of the canker organism by the wind, although that is of course a considerable factor, but also to the fact that a strong wind, whipping the twigs and foliage, causes spine wounds and surface injuries to the leaves resulting in infection by the canker organisms under conditions in which they would not develop on unwounded tissue. It has been shown in unpublished experiments on the moderately susceptible species that canker will develop at a wound on a mature or nearly mature leaf, while infection will not take place, or at least will not develop, on uninjured surfaces of the same leaf. The prevention of the whipping and stabbing of the branches and foliage by the wind is therefore also an essential point. The windbreaks at Lamao consisted of dense thickets of bamboo, 10 to 15 meters high and almost impenetrable. Such windbreaks were very efficient and very materially aided citrus-canker control work.

At Lamao it has been observed that, by attention to such apparently minor points as the control of chewing insects, the utilization of windbreaks, and the regulation of the growing periods, much can be done to minimize the development of canker on the moderately susceptible hosts. The comparison of results at Los Baños with results at Lamao supports this conclusion and would point to these indirect methods of control as being fully as important, if not more so, as prevention of the disease by spraying.

DIFFERENCES IN SUSCEPTIBILITY OF CITRUS SPECIES AND VARIETIES IN THE EXPERIMENTS

It became apparent at Lamao that there are wide differences in the susceptibility to canker(9) of the different species of *Citrus* which necessitate a separate consideration for each species when working with, or discussing, such subjects as the control of canker, the injuries resulting from canker, and the eradication of canker. Many of the contradictory statements with regard to various phases of citrus canker would seem to be due to a confusion of the species or, in some cases, to the failure to connect such statements with the host under observation. A consideration of the susceptibility of the different species at Lamao in connection with the feasibility of control methods has been possible and therefore is briefly presented here.

At the beginning of these experiments the trees of the mandarin orange varieties had little or no canker. Very few infections were found, and it was a carefully recorded observation that more than 33 per cent of the few infections that were found upon mandarin orange varieties occurred at very evident wounds, either spine wounds or insect injuries. Under such conditions, as shown in the foregoing tables, complete elimination of citrus canker upon the mandarin orange varieties was very prompt and there were no recurrences of infection; also, the operations were simple and inexpensive. Many of the citrons (*C. medica*) were also slightly susceptible and very easily freed from canker. The mature calamondin trees were never observed in the writer's experience to be cankered, and control measures for citrus canker on this host were entirely unnecessary. These species, the mandarin oranges (*C. nobilis* var. *deliciosa*), the citron (*C. medica*) together with the calamondins (*C. mitis*) and, of course, the round kumquats (*Fortunella japonica*), constitute a class of commercially grown citrus fruits upon which control is simple and very often unnecessary, at least when trees are mature. These varieties might be classed as a group, class 1, the members of which are so slightly susceptible that they can mature and produce fruits with no injury from citrus canker, even in the absence of control treatments.

At Lamao almost complete elimination of canker was obtained very quickly on the American-grown lemon varieties (*C. limonia*) and the so-called Mediterranean varieties of the sweet oranges (*C. sinensis*), such as the Valencia, Jaffa, Mediterranean Sweet, Ruby, St. Michael, and Du Roi. In this class should also be

placed the Tahiti lime (*C. aurantifolia*). In as much as all the other limes under observation were found to be highly susceptible, the relative freedom from canker of the Tahiti lime is very striking and should be taken advantage of in commercial growing. The species and varieties enumerated might be considered as class 2, all of which showed such a quick elimination of canker at the beginning of the control attempts that such measures would seem to be economically feasible. The Unshiu varieties known in America as Satsuma oranges (*C. nobilis* var. *unshiu*), at least the Ikiriki, Owari, Zairai, Ikeda, and Wase, although not shown in these Lamao plats, from later experiments would also seem to belong in this class of susceptible but easily controlled fruits.

A third class would contain many of the varieties of the sweet orange originating in Florida, such as the Pineapple, Homosassa, Magnum Bonum, Whittaker, and Parson Brown. This class of sweet oranges is more susceptible than the varieties of the Mediterranean group and would be more difficult to control. In this class would also be placed the Natsumikan of Japan and many of the pummelos, or East Indian type of *C. maxima* (*grandis*). Several of the strains of navel oranges would probably also be put in this class. The strains of the navel orange exhibit a considerable range of susceptibility; that is, some navel orange trees have been observed which were but very slightly affected, although exposed to infection for a number of years, while other strains, after exposure to infection for only one month, showed large percentages of affected fruits and foliage. The determination of the susceptibility of these various strains of navel oranges is an important problem to be solved. To this class may be also added the Triumph grapefruit. The Triumph is the only variety that has been under observation which has shown any modification from the extreme susceptibility of the American-grown grapefruit varieties. It is by no means resistant, but its lesser degree of susceptibility to canker would perhaps make it of more value for commercial growing, and it might possibly serve as a basis for breeding toward resistance.

Upon the varieties given above in what may be called the third class, it has been shown at Lamao that canker can be controlled. It is a question, however, as to whether this control is economically feasible. The control obtained on these species and varieties, as has been shown, was obtained only after very careful pruning and a very large number of spray applications. The experiments have been continued in Japan and it is hoped that a report

can be made on the economic feasibility of such control in one or two years.

The fourth class would include the extremely susceptible grapefruit and lime varieties. Good control has been obtained on a few of these varieties, while on others the amounts of canker have at least been reduced. Such reductions however have been secured only after the application of an uneconomical number of sprays and much time in the careful pruning out of twig cankers. Under Philippine conditions, it is easily apparent that control methods on the American-grown grapefruit varieties and on the West Indian lime varieties is not economically practical by the methods employed. With this class of citrus varieties therefore the results are similar to those obtained by Wolf.(21)

TOTAL ERADICATION BY PRUNING AND SPRAYING

The following experiment is presented to show the results obtained by another method of attack. An attempt was made on a small isolated citrus planting at Singalong, Manila, entirely to remove all leaf, twig, and branch cankers, thus eliminating all sources of reinfection, in the endeavor to determine whether or not eradication of citrus canker could be effected without the total destruction of trees.

The planting consisted of two rows of nursery trees which had been allowed to mature in place, without removal to the orchard. The lime trees were from four to five years old at the beginning of the experiment; some of the mandarin trees were three years old, while others of the same species, and the calamondin trees, were one year old. This planting was fairly well isolated from other sources of infection. The trees were cultivated, irrigated, and cared for entirely according to the usual American orchard practices. The treatment of this planting was as follows:

August 19, 1917. Formalin 1–80 solution.
September 1, 1917. Formalin 1–80 solution.
September 10, 1917. Formalin 1–80 solution.
September 16, 1917. Trees pruned for the removal of twig cankers.
September 17, 1917. 4–4–50 Bordeaux mixture plus resin, sal-soda sticker.
October 9, 1917. 4–4–50 Bordeaux mixture plus resin, sal-soda sticker.
November 9, 1917. Neutral Bordeaux mixture plus powdered, neutral, lead arsenate to make 1–50 mixture.
December 17, 1917. Neutral Bordeaux mixture plus cresol-kerosene emulsion.

December 29, 1917. Yothers's oil emulsion plus formalin 1–100.
February 6, 1918. Cresol-kerosene emulsion.
May 20, 1918. Neutral Bordeaux mixture.
June 10, 1918. Neutral Bordeaux mixture.
July 6, 1918. Neutral Bordeaux mixture plus cresol-kerosene emulsion.

The plan of this spray campaign was to use several applications of strong formalin solution as clean-up sprays at first, in order to reduce the amounts of citrus canker infection and so lessen the work of pruning out the cankered twigs and foliage. The trees were in many cases partially defoliated by these strong formalin sprays, but for the most part the cankered leaves were the ones to fall. The formalin sprays were followed by an extremely careful pruning out of all twig cankers. Having attempted entirely to remove all the sources of infection in this way, prevention of new infection was attempted by the application of Bordeaux mixture. No spraying of the soil was carried on in as much as it had been shown by the present writer(10) that the canker bacteria are quickly killed out in Philippine orchard soils. The character of the trees and the results of these treatments are shown in Table 14.

From the viewpoint of total eradication it is to be seen that this experiment yielded negative results. After the initial careful removal of all sources of infection there were recurrences of canker in a number of cases. In the small planting employed in this experiment such recurrences were noted promptly and removed; in a large commercial planting of susceptible trees such close observation could not be maintained with financial profit.

In this connection, however, consideration should also be given to the susceptibility of the host under treatment. Thus, although it is evident that such attempts at eradication were unsuccessful on the very susceptible lime varieties, a very exhaustive experiment would be necessary upon a planting exclusively of trees of the mandarin orange or Satsuma orange varieties before a similar conclusion could be adopted for such a host.

To avoid confusion it should be made clear that, although calamondin and mandarin orange trees when mature are considered resistant to citrus canker, they will exhibit a considerably greater degree of susceptibility when young in nursery rows. This has been pointed out more in detail previously by the present writer.(12)

TABLE 14.—*Degree of citrus canker affection of trees in the citrus planting at Singalong during various stages of attempted eradication work.*

Variety.	Species.	Leaves affected.							
		August 17, 1917.		January 3, 1918.		May 20, 1918.		June 16, 1918.	
		Per cent.	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*	*Per cent.*	*Number.*
Native mandarin orange	*Citrus nobilis*		20	0	0	0	0	0	0
Do	do		20	0	0	0	0	0	0
Do	do		18	0	0	0	0	0	0
Do	do	100			1	0	0	0	0
Do	do		20	0	0	0	0	0	0
Do	do	2		0	0	0	0	0	0
Do	do	50		0	0	0	0	0	0
Calamondin	*Citrus mitis*	100		0	0	0	0	0	0
Do	do	1		0	0	0	0	0	0
Do	do		19	0	0	0	0	0	0
Do	do	100		(a)	(a)		1	0	0
Do	do	50		0	0	0	0	0	0
Do	do	0	0	0	0	0	0	0	0
Do	do		10	0	0	0	0	0	0
Do	do		1	0	0	0	0	0	0
Do	do		5	0	0	0	0	0	0
Do	do	95			2	0	0	0	0
Do	do		5	0	0	0	0	0	0
Do	do		1	0	0	0	0	0	0
Do	do		20	0	0	0	0	0	0
Do	do	50		0	0	0	0	0	0
Do	do	50		0	0	0	0	0	0
Do	do	10		0	0	0	0	0	0
Native lime	*Citrus aurantifolia*	10		0	0	0	0	0	0
Do	do		3	0	0	0	0	0	0

Do	do	5		0	0	0	0	0	0	
Do	do	50		0	2	0	0	0	0	
Native pummelo	*Citrus maxima*		3	0	0	0	0	0	0	
Native mandarin	*Citrus nobilis*	0	0	0	0	0	0	0	0	
Do	do	50		0	0	0	0	0	0	
Do	do		5	0	0	0	0	0	0	
Do	do	0	0	0	0	0	0	0	0	
Do	do	0	0	0	0	0	0	0	0	
Native lime	*Citrus aurantifolia*	50		0	0	0	0	0	0	
Do	do	50		(b)	(b)		20	(b)	(b)	
Do	do	50		0	0		5	0	0	
Do	do	50			9	0	0	0	0	
Do	do	25			4	0	0	0	0	
Hybrid	*Citrus* species	0	0	0	0	0	0	0	0	
Do	do	5		0	0	0	0	0	0	
Do	do	0	0	0	0	0	0	0	0	
Do	do	0	0	0	0	0	0	0	0	

[a] Two twigs cankered.

[b] One twig, leaves cankered.

DISCUSSION OF RESULTS AND THEIR APPLICATION

In the Philippines it would seem to be possible, by the selection of the proper varieties and the use of the methods described previously, to raise citrus fruits free from citrus canker. However, in other countries, as in Florida, where the susceptible grapefruit and lime varieties are already planted and very largely grown, control of such very susceptible varieties by the methods employed here would be very expensive and apparently not economically feasible. It seems safe to conclude that the practical control or the prevention of citrus canker by the present known methods on very susceptible hosts, such as the American-grown grapefruit varieties and the West Indian limes, can only be accomplished by the total exclusion of the disease from entire localities; this conclusion possibly would not apply to arid or semiarid countries. An alternative would be the securing of resistant varieties of these species, either by breeding or from among the little-known, already existing varieties of the East Indies and Southern Asia.[7]

In regions of the United States where the very susceptible lime and grapefruit varieties are not grown, control upon the less susceptible varieties by these methods would be possible, but the economic feasibility of these methods is not yet proven. In some regions, as in Alabama and Mississippi, where only slightly susceptible varieties such as the Satsuma strains are grown commercially, control methods would be practicable or even unnecessary.

SUMMARY

1. The development of the experiments has shown that in addition to preventive sprays the following factors contributed very largely to minimizing canker infection: Removal of sources of infection by pruning and drastic "clean-up" sprays; stimulation of foliage growth to occur at periods of the year unfavorable to canker dissemination or development; the control of violent winds by windbreaks and orchard situation; and the control of chewing insects.

[7] The writer has obtained pummelos in Hongkong, imported from Saigon and Bangkok, which were entirely free from citrus canker; they were commercially seedless and possessed the desirable flavor and texture of the American-grown grapefruit.

2. The preventive sprays used with any degree of success were Bordeaux mixtures and Burgundy mixtures of various concentrations. Lime sulphur, formalin, and ammoniacal copper carbonate solutions were unsuccessful under Philippine rainy season conditions. Copper sprays were not wholly successful, although they effected tangible reductions in canker infections.

3. The work has made apparent, and it has been one of the principal objects in the presentation of this paper to point this out, that the most important consideration in discussing the feasibility of control, the seriousness of citrus canker, and such subjects, is a knowledge of the reaction to the disease of the different species and horticultural varieties. The wide range in the susceptibility of the *Citrus* species necessitates the separate discussion of canker-control possibilities for each host or class of hosts.

4. The conclusion is apparently safe that control upon the very susceptible lime and grapefruit varieties is not economically feasible by the methods employed. Upon the sweet oranges of Florida origin and such varieties of less susceptiblility, control may be practicable; further work is now in progress upon this point. The sweet orange of the so-called Mediterranean varieties, some of the lemons, and the Unshiu orange varieties comprise a class of fruits of very moderate susceptibility; control apparently would be economically practicable on such varieties. Control was very easily obtained and was hardly necessary upon the mandarin orange varieties, the calamondins, and the citrons. Attention has been called to several exceptions from the extreme susceptibility of the lime and grapefruit varieties; such exceptions may be of value for cultivation in regions of universal distribution of citrus canker.

5. An attempt to obtain complete eradication of citrus canker without the total destruction of the trees was conducted on a small isolated plat of calamondin, mandarin orange, and lime trees. From the viewpoint of total eradication, negative results were obtained on this plat. In this case, as in others, the results must be considered in connection with the *Citrus* species used as hosts in the experiment. Thus these results, although applicable to the limes, and probably to the grapefruits, should not be considered applicable to the less susceptible varieties, such as the mandarin and Satsuma oranges, until more ex-

haustive experiments have been carried on with a planting exclusively of such a slightly susceptible host.

6. In a district or region in which the extremely susceptible varieties such as the limes and grapefruits constitute the important, commercial orchards, either complete eradication of the affected host plants or substitution of less susceptible hosts is apparently the only means of preventing severe losses from this disease. From the results presented in this paper such is not the case, however, with the less susceptible species.

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ILLUSTRATIONS

PLATE 1

Citrus leaves showing cankers following attacks of leaf-chewing insects.

PLATE 2

Citrus leaves showing cankers following trail of leaf miners.

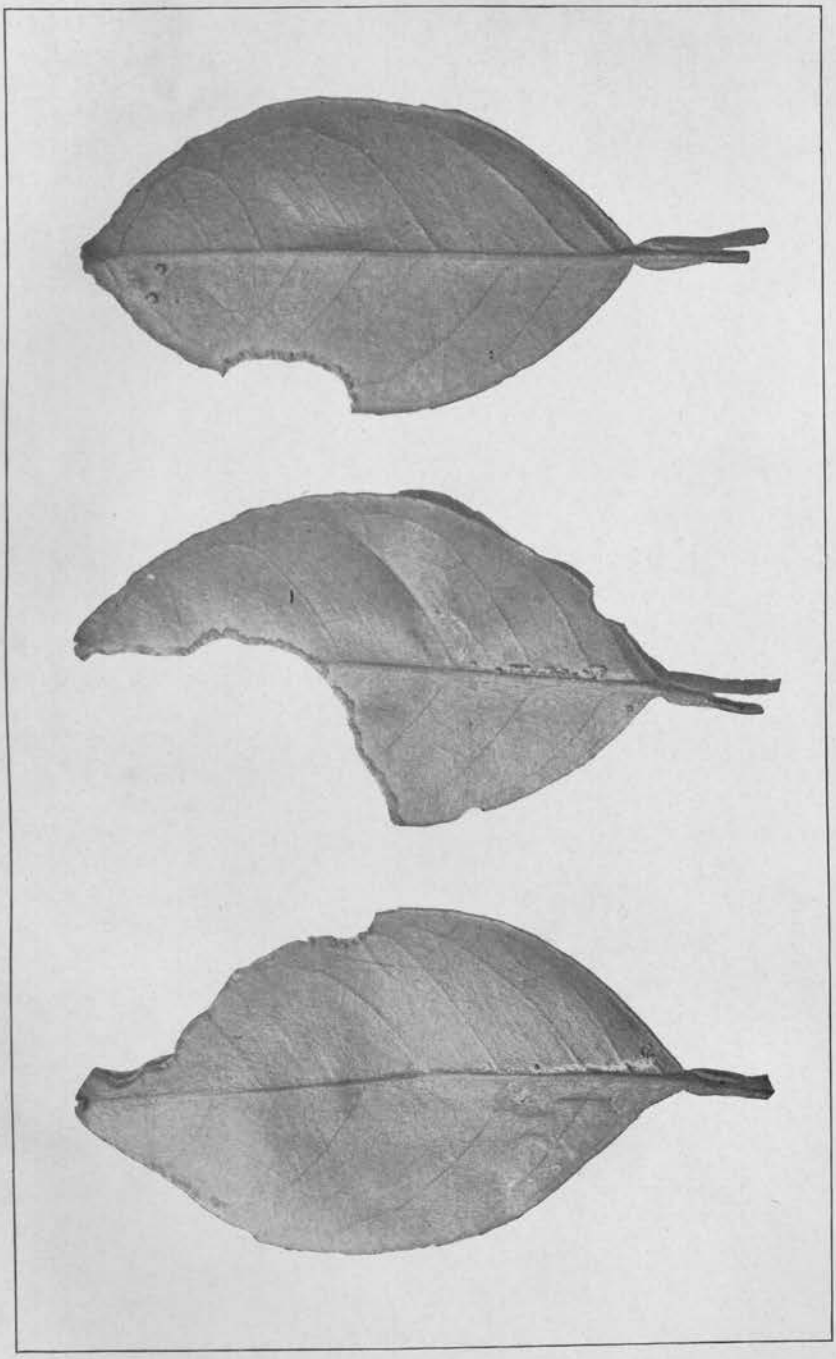

PLATE 1. CITRUS LEAVES SHOWING CANKERS FOLLOWING ATTACKS OF LEAF-CHEWING INSECTS.

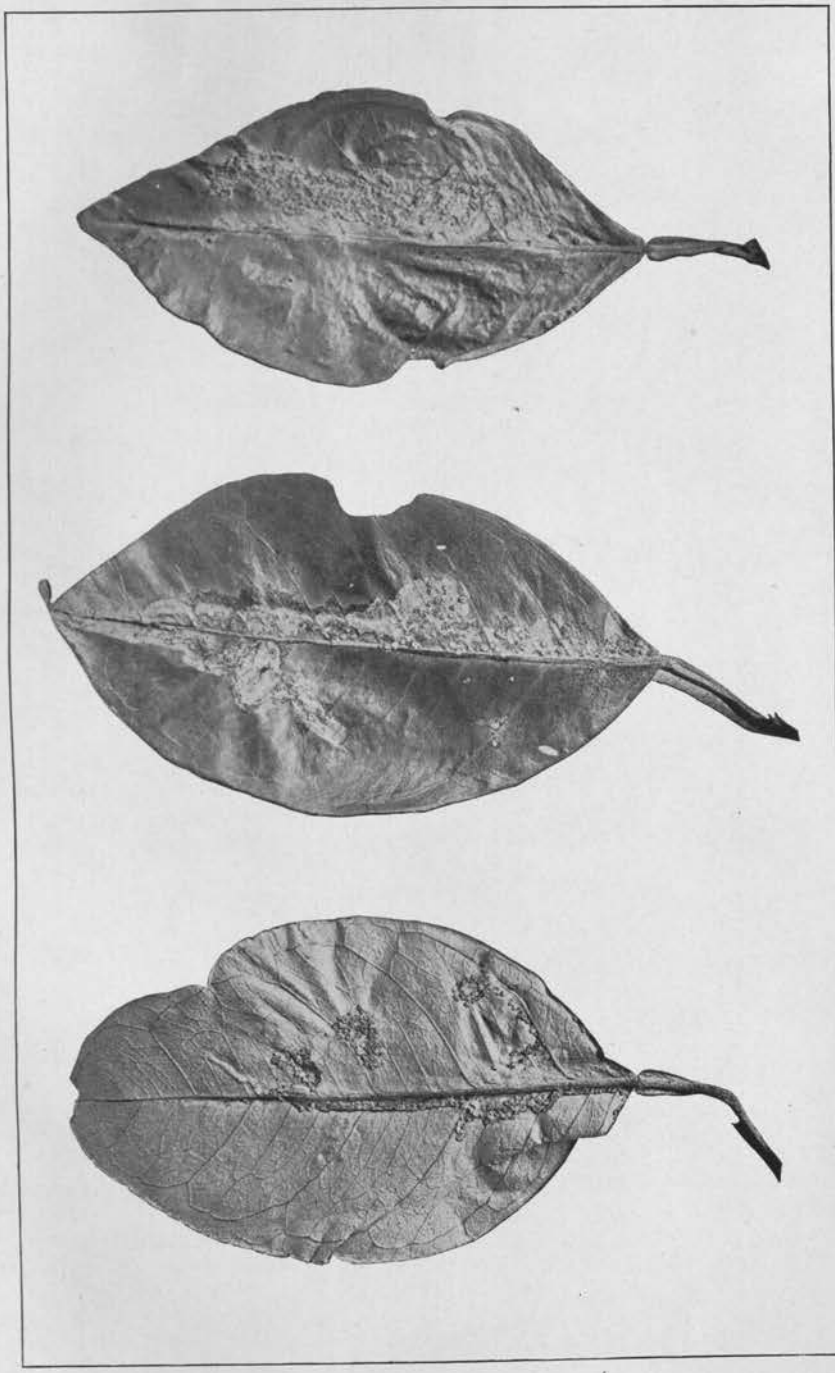

PLATE 2. CITRUS LEAVES SHOWING CANKERS FOLLOWING TRAIL OF LEAF MINERS.

KALINGA TEXTS FROM THE BALBALÁSANG-GINAANG GROUP [1]

By Otto Scheerer

ONE TEXT FIGURE

LOCATION

The people at present officially designated as Kalinga occupy a central position in the interior of northern Luzon. They have for neighbors in the north the Apayao, in the west the Itneg (Kal. *Itnog*), in the south the Ibontok, and in the east the Ibanák and Gaddang. Their country consists, in the main, of a portion of the high ridge of the Cordillera Central and of the lower sierras which from this backbone stretch forth toward the east, sending their waters in numerous streams to the Rio Chico de Cagayan. On the upper course of this river is situated the town of Lubuagan, the capital of the political subdivision of the Mountain Province known as the subprovince of Kalinga. The accompanying sketch will show the general disposition of the Kalinga territory. (See page 177.)

NAME

Individuals of this tribe spoken to by me called themselves *Kalingga* or, more idiomatically, *Kalingka*. Since *kaling-á* in Ibanák and *kalinga* in Gaddang (the latter in the spelling of P. Malumbres) both mean "enemy," it may be surmised that the name in question was orginally bestowed upon the people from outside.

SUBDIVISIONS

In spite of the Kalinga having merited up to recent times the fame of bold warriors and inveterate head-hunters, their territory appears to be almost nowhere demarcated by sharply drawn ethnic boundary lines such as those antecedents might lead us

[1] The texts here published are the first coherent records made of the speech of some little-known dialect groups of northern Luzon. While hardly more than raw material, their publication must be considered as opportune since, with the profound and rapid changes now going on in the Islands, it becomes a matter of doubt if dialects like the present will still be in existence when a systematic investigation may become possible at some time in the future.

to expect. Almost on all sides zones of transition are reported, peopled by the offspring of the Kalinga's intermarriage with his neighbors. It becomes thus difficult to treat of the Kalinga as of a unit without making almost at every step allowance for intermixture. Modern ethnographers like Worcester, Beyer, and Cole, who, after personal investigations on the spot, have first recognized a distinct and prominent tribal unit among the jumble of so-called "tribes" reported in Spanish times from the territory above defined, and who have fixed on that unit the name Kalinga, have found it necessary to subdivide this people into a number of groups according to admixture of blood, culture, or dialect.[2] Beyer distinguishes the following groups:

1. The pagan Gaddang.
2. The Kaláua or Kalágua.
3. The true Kalinga of the lower Saltan, Nabayugan, Bukao, and Talifugu river valleys.
4. The Balbalasang-Gináang group.
5. The Lubuagan-Sumadél group.
6. The Mangali-Lubo group.

Of these he says that in the present state of our knowledge this must be considered as a rough and tentative grouping only.[3]

The following items of information gathered by me from members of the Balbalásang-Gináang group support the theory of a close relationship existing among the different Kalinga dialects. The Balbalásang people designate their speech as *kainalingka*. (Salegseg *Kenalingke*.) At those occasions when the chiefs of the various townships constituting the subprovince of Kalinga meet at the capital Lubuagan to confer with the

[2] Cf. Worcester, The non-Christian tribes of northern Luzon, Philip. Journ. Sci. 1 (1906) 791–805 and 818–826; also Fay-Cooper Cole, Distribution of the non-Christian tribes of northwestern Luzon, Am. Anthropologist 2[3] (1909). An older conception of the Kalinga is found in the following translated quotation from Blumentritt, Versuch einer Ethnographie der Philippinen. Gotha (1882) 36: "According to Semper (Erdkunde, X, 256) the name Calinga seems to be a collective designation of unknown signification since thus are called also all the pagans who inhabit the provinces of Isabela, Cagayan, and Nueva Vizcaya. I designate here with this name that pagan Malayan tribe which lives in the same mountain stock as the Aripa, though only in its northern part, and goes especially by the name Calinga. But little is known of them."

[3] Beyer, H. Otley, Population of the Philippine Islands in 1916. Manila (1917) 50–51. On page 43, in treating of the Ibanák, the author says: "At least one quite different dialect exists. This is known as the Itávi or Malauég. The people speaking it are probably christianized Kalingas."

Lieutenant-Governor, they and their followers speak among themselves *kainalingka*, in which they are able, according to my informants, to make themselves mutually understood, with more or less difficulty, in spite of dialectic differences. Two

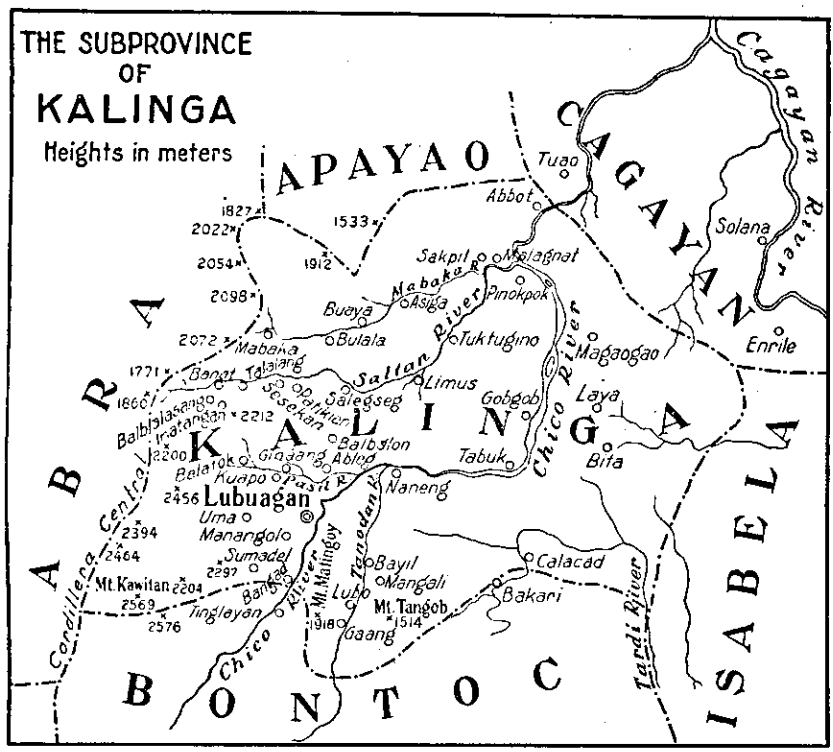

FIG. 1. The subprovince of Kalinga.

townships alone are pointed out as not coming within this range of general intelligibility; those are Bakali (?<*iba kali* other speech) and Kalakkad; to communicate with these the Iloko language is made use of.[4]

[4] The map of Northern Luzon of the Coast and Geodetic Survey (1912), on which my sketch is in part based, shows on the upper course of what is called farther down the Tardi River the two settlements of Bocale and Calacad, situated east of the Mangali-Lubo district. To Governor Carpenter, of the Department of Mindanao and Sulu and director of the Bureau of Non-Christian Tribes, I owe the information that by Executive Order No. 53 of May 29, 1914, "all that territory lying south of the Tardi River and the territory drained by the Siffu River now situate in the subprovince of Kalinga, Mountain Province," was transferred from the said subprovince to that of Bontoc.

In view of these facts the existence within the Kalinga territory of a goodly number of dialects may be expected. Whether these, once known in their totality and compared with one another and with the surrounding stocks, will show common charateristics leading to the establishment of a typical Kalinga speech as represented in its purest form by one or the other of these dialects, is one of the interesting questions the solution of which will reward the linguistic explorer of this region. The present state of our knowledge in this regard is characterized by Beyer in these words:

> The mixture of Kalinga dialects is as confusing as their type and culture, and in passing from one district to another most striking differences in phonetics are observed. Structurally those of the west seem to resemble the Iloko group, while the eastern dialects are closer to the Ibanag. We have too little information at the present time to attempt a classification of the Kalinga dialects, or even to state their number.[5]

The grouping of these dialects thus will have to follow for the present merely geographical lines.

BIBLIOGRAPHICAL NOTES

The only published records known to me of the speech of people coming under the designation of Kalinga as now in use are the following:

1. Schadenberg, Alexander, in Beiträge zur Kenntniss der Banao–Leute und der Guinanen, Gran Cordillera Central, etc., Verhandl. Berl. Anthr. Ges. (1887) 152–159. A vocabulary of some 660 words of the "Guinaan dialect as spoken in the rancheria of Copacopa." In this as in another vocabulary from central northern Luzon, this earliest scientific explorer of those regions shows himself to have fallen only too often a victim to the habit of those natives of substituting Iloko or other lowland terms for their own idioms when dealing with foreigners.
2. Meyer, Hans, Guinanisch-Tinguianisches Vocabular, in Eine Weltreise, Anhang: Die Igorroten. Leipzig (1884). Some 120 words.
3. Scheerer, O., in Linguistic travelling notes from Cagayan, Anthropos 4 (1909) 3 and 4. A list of 66 words from the rancheria of Gobgob on the Rio Chico.

INTERTRIBAL RELATIONS

The group of Kalinga whose speech is recorded in the following texts is at home on and around the upper course of the Saltan River where, according to Cole, they have married with the Igorot and Tinggian.

This author says:

[5] Beyer, op. cit. 51.

The towns of the upper Saltan river have drawn much from the three tribes which have contributed to their population, but the Tinguian material culture is the most pronounced. The typical costumes, method of hair-dressing and the arm-beads of the women, in vogue in Abra, are all found here. Agriculture is extensive, and the terraced fields compare favorably with those of Bontok. All kinds of domestic animals known to the natives of the coast are possessed by these people. The best iron-work of northern Luzon comes from this section, and their head-axes and spears have a wide distribution over the whole Tinguian and Kalinga territory.[6]

Beyer says of them:

In physical type they are more or less like the true Kalingas, but their culture and speech is a blended mixture of Apáyao, Kalinga, Tinggian, and Bontok. Out of this mixture there have been a number of curious and unique cultural developments.[7]

I may add to this that the different members of this group who were spoken to by me called themselves, as already stated, *Kalingká*, giving therewith evidence of their being conscious of belonging all to one and the same tribe. Since olden times they maintain trade relations with the Tinggian in the west, whom they call *Itnog* and whom they consider their friends; going as far as *Banged* (Span. Bangued), they take down to them rice (Bal. *pākoi* unhulled rice, *phínāyu* hulled rice) and tobacco (Bal. *taphiāko*) in change for salt (Bal. *asin*), pigs (Bal. *Pfūyok*[8]), woven stuffs (Bal. *lōpot*), beads (Bal. *ullayau*), metal pipes (Bal. *siwako* pipe), etc.; since the advent of the American régime they also trade with the people of Tuao and Piat in Cagayan to whom they bring likewise rice in return for salt, iron (Bal. *Phyāyang*), etc. Their main trade route lies along the Saltan River (Sal. *Saƛtan*) whose banks, hemmed in by steep rocks forming narrow and winding gorges, have given it, in local parlance, the name *Maƛokpfūb*, the cliff-bound. The significance of this river as a landmark is evidenced by the fact that the terms *chaya* and *lákūd*, denoting two cardinal points, have for the river-dwellers primarily the meaning of "up river" and "down river," respectively, and only according to the orientation of the river those of "west" and "east," respectively.

BALBALÁSANG

Balbalásang (locally *Phyaiphyayásang*, from *phyayásang* maiden) is officially stated to count at present approximately

[6] Op. cit. 342.
[7] Op. cit. 50.
[8] *O* quite open, as generally in these dialects.

1,048 souls. It is to be conceived as a district comprehending, besides Balbalásang proper, a number of "rancherias" or settlements (*phophóyoi*). The following were indicated to me as belonging socially, though not necessarily politically, to Balbalásang, and as speaking with little difference the same dialect:

Pasuál.	Kallagan.	Talagan.	Malibkóng.
Pattékyan.	Saʌtan.	Photlok.	Phulayāyau.[9]
Inilagan.	Sisík-an.	Phyánagan.	

The chief peculiarity of pronunciation that strikes the ear of the traveler who enters the Balbalásang district from the west is the sound which I represent by *ph* and which before *a* becomes *phy*. From a comparison of the word *phyayásang* above quoted with Ilk. *balásang* maiden it may be seen that *ph* replaces other Phil. *b*, and that the second *y* in that word stands for other Phil. *l*. Similar examples are: Ilk. *bató* stone, Bal. *phyató;* Tag. *gubat* forest, Bal. *kinophyat* same meaning; Ting. *banug* a certain eagle, Bal. *phyanúg*. The sound here in question is a pure bilabial, transitional from a stop to a fricative, and in so far difficult to judge correctly as not only its position in the word and the sounds preceding and following it are apt to make it fluctuate from *p* over *pf* to *f*, but also different speakers do not all produce it in exactly the same way.[10] On the question whether it is in all cases unvoiced—as I give to understand by the uniform writing *ph*—I must reserve a judgment which could be given only after a more extended investigation than was possible to me. I may say, however, that before *u* this sound approaches either *pf* or *f* so closely that I was tempted to write, for instance, *uppfu* (young of animal) for *upphu, naāfús* (finished) for *naāphús,* and others similarly.

This fluctuating sound is also found in the dialects of Gináang and Salegseg where it shows again some modifications.

Another notable feature of Bal. phonology, found likewise in Gin. and Sal., is a velar stop lying, in strength, between *g*

[9] Names here given are as locally pronounced; outsiders pronounce them somewhat differently.

[10] Though different in origin, this sound appears to be very similar to the one described by Conant in his F and V in Philippine languages, Bu. Sci. Div. Ethn. Publ. 5[3] (1908) 139; treating of the faulty pronunciation of *p* by individual Filipino children from various tribes, the author says that "the sound is produced by expelling the air through the lips when closed, but so relaxed that a very slight explosion is immediately followed by an almost imperceptible spirant, the result being a *pf* sound, the constituent elements of which are so blended as to be hardly distinguishable from each other."

and *k*. Also respecting this sound a definite statement as to the presence of voice must be reserved to further more leisurely observation. The general impression was that of a strongly articulated *g*, my unwillingness to set this sound down as a *k*. being perhaps due to the fact that it is produced considerably farther back than *k* in English. Before *a*, especially before stressed *a*, it acquires the same strength as, for instance, *c* in English cat, even with some aspiration following it: *kaling-ká* almost *kaling-khá*. Disregarding fluctuations observed, I represent it for the present uniformly by *k*: *tákū* person, *iníngkāu* there was.

The consonantal diphthong *ch*, evolved, as in Inibaloi, from *d*, and which occurs in all three dialects here recorded, was pronounced much softer than in the first-named language. A study on the spot might lead to the adoption of a symbol corresponding to dʒ of the International Phonetic Association.

SALEGSEG

Salegseg (locally *Saʎogsog*) is reached from Balbalásang in, four hours on horseback down the Saltan River. Official statistics give the population as about 940. Affiliated settlements speaking practically the same dialect are:

Pfūʎo (Bolo).	Chusō(k).	Kœwœan.	Possa.	Póttau.
Upoʎ.	Kā-wong.	Ōta.	Legleg.	Kilāyun.
Lopwóng.	Alengngag.	Náwoi.	Ta-wang.	Pfuayantoʎ.

My informant, a native of Salegseg proper, spontaneously stated that their dialect was about the most difficult to understand for the Kalinga of other districts, and this on account of its peculiar phonetics. Asked for the name of their speech, he unhesitatingly gave it as *kenalingkə* (<*kainalingka*). The chief phonetic peculiarities are:

1. A mixed vowel of the *ö* class replacing other Phil. *a* according to rules yet to be established. Being quite open, it is best represented by the *œ* of the International Phonetic Association. Isin. *gawa* middle, Bal. *kawa*, Sal. *kœwœ*. Occasionally this sound becomes rather indistinct (the *ə* of the Int. Phon. Ass.): Tag. *buaya* alligator, Bal. *phuāya*, Sal. *pfuœ̄yə;* Ilk. *dua* two, Bal. *chua*, Sal. *chuə*.
2. The peculiar Bal. bilabial *ph*, representative of other Phil. *b* is found in Sal. in about the same average form only before *i*: Tag. *gabí* night, Bal. *laphí*, Sal. *laphí*. Before an original *a* it becomes what might be called a hard *b* (I employ for it the symbol *ɗ*) and thus forms—seemingly according to the quantity of the syllable—either the syllable *ɗœ* (Inib. *mabayag* what lasts much time, Sal. *maɗœyəg;* Span. *bayoneta* bayonet, Sal. *ɗœyonēta;* Ilk. *bása* idea of reading, Sal. *ɗœssa;* Ilk. *ibagá* what is told, Bal. *iphyakɗ*, Sal. *iɗœgé*), or the group *ɗŭa* (Phil. *bató* stone, Sal. *ɗŭató;*

Phil. *basá* wet, Sal. *ɗŭassá*). An exception would seem to be Sal. *ɗoɬoi* house (Bal. *phoyoi*, Ilk. *balái*). The essential distinction between the sounds represented by *b* and *p* is, of course, the presence or absence of voice, a question which, in reference to the sound here under review, must be left for future investigation. Before *u* (*o*) a fairly distinct, though very light, affricate is heard: *pfuēyə* alligator, quoted above; Ilk. *bumangon* one rising, Sal. *pfumangon*; Ilk. *umisbó* who makes water, Sal. *umispfó;* Phil. *Bontók*, Sal. *Pfuntók*.

3. A sound produced by articulating an *l* with the tip of the tongue not touching the alveoli but passing more or less freely through the teeth, as my informants very clearly demonstrated to me. I use for it the symbol *ɬ*. The attempt to produce this sound, which is not found in English, is best made with an initial vowel; thus with *o*, for instance, a diphthong approaching *oi* will result; compare Ilk. *luppó* thigh, Inib. *ulpó* Sal. *oɬpó*. The name of the river Saltan, of the town Salegseg, and of the barrio (detached suburb) Bolo are locally pronounced *Saɬtan, Saɬogsog,* and *Pfūɬo*, respectively. The Spanish word for highroad, *calzada*, becomes in Sal. *kaɬsa*, the final syllable *da* being left out presumably under the mistaken belief that it is the possessive suffix of the third person plural *da*. Also in Bal. the change from other Phil. *l* to *ɬ* will be found through comparison (Ilk. *dakkél* large, Bal. *chakkói*, Sal. *chakkóɬ*); the pronunciation of the sound is there, however, so glib and free of an admixture of *l* that I have not considered it necessary to use a special symbol for it. In Sal. the sound in question is often very deceptive and in the footnotes to the texts there will be found pointed out cases where it sounds almost like *l*.

Mention is to be made here also of the fact that tenues in final position are pronounced, especially in isolated words, with extreme softness making them sometimes scarcely audible: *Chusō* (*k*) a part of Salegseg, *áwa*(*k*) waist, *chœwa*(*k*) a semireligious ceremony (Ting. *dawak*), *awi*(*t*) load, *nasū-yo* (*p*) one sleeping, etc. Apparently this is due to the release of the stop being effected in a scarcely perceptible manner.

GINÁANG

Gináang, a town situated about half a day's ride southeast from Balbalásang, and about two hours northwest from Lubuagan, between the Rivers Pasíl and Tabía. The inhabitants, said to have been in former times the terror of their more peaceful neighbors and referred to by the Spaniards as "la tribu de los Guinaanes," number according to recent official statistics about 1,051 souls. Rancherias popularly affiliated with Gináang and speaking, with perhaps slight difference, the same dialect, are:

Púgung.	Mayoksád.	Yugyúg.
Poyāau.	Puāpu.	Gā-chang.
Bəktayan.	Matóngngak.	

The dialect of Gináang, as recorded in the following texts, is quite evidently part of the general Kainalingka speech-group; one of my informants, however, a son of the old fighting chief Atumpa of Gináang, had for it the special name *Gininàang* and disapproved of the generalizing term Kainalingka because of the existing dialectic differences. He had to admit, nevertheless, the similarity of their dialect to that of Balbalásang and, more especially, to that of Balatók, another considerable town some distance up the Pasíl River, with whose inhabitants they have no difficulty to converse.

Gináang phonetics, while in general very similar to those of Balbalásang, show in certain points a distinct weakening. The characteristic *ph* sound has less friction and approaches more a strong *b*. Similarly the dubious velar stop mentioned under Balbalásang inclines in Gináang more to *g*, so that words like *tákū, íngkāu,* and others I was tempted to write *tágū, inggāu,* etc. The consonantal diphthong represented in English by *ch*—and thus given also in the texts—often sounds rather like dʒ than tʃ, while some words seemingly ending in *d*, as *maíd, úkūd,* really wind up with a very slender hesitating sibilant: *maíd-ʃ úkūd-ʃ*. The almost inaudible final *k* mentioned under Salegseg is found also in Gináang where, moreover, initial and intervocalic Phil. *k* are elided: Inib. *kalbían* last night, Gin. *ayabían;* Bal. *káisan* gone away, Gin. *áisan;* Inib. *karagwían* custom, Gin. *achawían;* Sal. *kan seka* to thee, Gin. *an si-a;* Ilk. *balái ko* my house, Sal. *phoyói-o*. In place of the disappeared *k* no glottal check could be detected, nor were my informants conscious of any such; all that remained was a slight hiatus.[11]

There remains finally to be mentioned a quality which in all three dialects consonants occasionally revealed to possess for binding syllables together. Thus a word which was heard pronounced, in the ordinary flow of speech, *imusón* (object of asking), showed, when spelled by the speaker in syllables, the division *i-mus-són*, the *s* belonging as much to the second syllable as to the third, without becoming thereby audibly geminated.

[11] The regular elision in the cases above cited of *k* of other Philippine languages clearly indicates the distinction to be made between this original *k* and the dubious *k* before mentioned which has evidently been evolved from *g:* for example, *ug-úkud,* story, shows *g* closing the first syllable and in its stead *k* in intervocalic position; Ilk. *kigau* becomes in Bal. *kikau;* compare also words ending in *g* and followed by connective *a:* Bal. *kaag* plus connective *a* gives *kaag-ka,* monkeys—which (Ilk. *kaag* the young of the monkey). Note also that in Gin. *taphyako,* a loan-word from Span. *tabako, k* was not elided.

(Wherever a long consonant was sounded this was recorded in writing by doubling it: *ummói, pillak.*) There was no opportunity to make this point an object of special study; it may, however, be kept in mind when dealing with the coalescence which is shown in the texts often to take place between the connective particles *a, ot,* and the final consonant of the preceding word: *chakkói-ya phyanúg* large eagle, *akit-ta iphíl* little crying, *phyanúg-ka manánap* eagle-which searched, *phyató-wot* stone-and, *liang-ngot* cave-and. The language did not, however, seem to be very strict in this respect, for, while the borrowed consonant was at times pronounced even after quite a considerable intervening pause, leading me at first to the belief in the presence of such independent words as *ta, wot,* at others there was either a simple addition of the particle to the preceding word (*acháyaoma liang* deep cave), or the consonantal accretion before the connective was lost through a pause.

The coalescence just treated finds its reverse in a number of words the staccato pronunciation of which leads to such writing as: *man-ái-áyam, na-ám-ámod, inám-amāan, pit-ongōna, inum-ummói, ság-ón, man-iwá-aʎ* and others.

In words not marked with an accent the weight of the pronunciation falls as a rule on the penult.

ACQUISITION OF TEXTS

The following texts were collected by me during vacation time at the Teachers' Camp in Baguio and at the farm school at Trinidad, Mountain Province, from some Kalinga students of about twenty years of age. Thanks to the courtesy of the authorities concerned[12] a series of sessions could be arranged with these young men. It was at first tried to have the students write down their stories, an attempt which proved, however, an entire failure, as the boys either frankly stated their inability properly to represent in writing the uncommon sounds peculiar to these dialects, or rendered sounds and words in a way that made it difficult for them to decipher after a while what they had written. I had thus to undertake the not easy task of following the flow of the story-teller's relation while trying, at the same time, to put into writing his utterances which at the time being were, of course, absolutely unintelligible to me. Still, after repeated readings and corrections each story took ulti-

[12] The facilities for my work kindly granted by Professor Wright, director of the Trinidad Farm School, and by Mr. McCann, of Teachers' Camp, Baguio, are sincerely appreciated.

mately a form that was pronounced correct, whereupon the translation into English was taken up, and one or the other point of grammar discussed.

The stories thus recorded were:

IN THE DIALECT OF BALBALÁSANG

1. *Sacha phyanúg kan aphít;* The eagle and the child; from the town of Balbalásang (Phyaiphyayásang).
2. *Sacha Changatag kan cha kaag;* Changatag and the monkeys; from the rancheria of Phulayāyau.
3. *Sachat Iphuāyan nangáyau ud Pattékyan;* Those from Buaya go on a headhunt to Patikían; from the rancheria of Pattékyan.

IN THE DIALECT OF SALEGSEG

4. *Se Aʃukəna kennan chit pfuāyə;* Si Alugan bitten by an alligator; from the rancheria of Pfuʃo.
5. *Ug-úkūd kan Lumawig;* The story of Lumawig; from the rancheria of Kā-wong.

IN THE DIALECT OF GINÁANG

6. *Ug-úkūd chat man-aman nagchayán;* The story of the father and child buried by a landslide; from the town of Gináang.

To these texts is added:

IN THE DIALECT OF THE TINGGIAN (ITNEG) OF ABRA AS SPOKEN IN THE TOWN OF PEÑARUBIA

7. *Mepanggep ta Itneg di Abra;* About the Itneg of Abra.

The last account, which was obtained from a young Tinggian student of the farm school already mentioned and is to my knowledge the first text ever published from that language, may afford students an opportunity to compare the Tinggian with the Balbalásang-Gináang dialects which latter are said to have been influenced by their western neighbors.

As regards the translation of the texts I should say that the liberties which I have occasionally taken with the English language are to be explained by the desire to reflect, as much as it can at all be done, the peculiarities of Kalingga diction.

A list of the personal and possessive pronouns in all dialects here recorded is added at the end.

PHYAIPHYAYÁSANG

SACHA PHYANÚG KAN APHÍT

1. Sachit nasulít sin phophóyoi ud Phyanakán iníngkāu chakkói-ya phyanúg. Inaikáuwa umói sit phophóyoi mang-

BALBALÁSANG

THE EAGLE AND THE CHILD

1. Long ago near the town of Banagán there lived a large eagle. Every day it came to the town to catch pigs and

āyas phoyók ya kikau. Maíd makapatói sit phyanúg tei umógyat chachit tákū.

2. Sat osán kidkícham iníngkāu osán aphít-ta man-ái-āyam sit páwai. Man-lín-lináwa sit man-ái-ayámana.

3. Masulít man inīlan chit phyanúg chit aphít. Manippókoi chit phyanúg ot chapyótonat aphít ot itáudna uschit philig.

4. Mangkolis mat aphít naāphús ngummato chit phyanúg. Na-ám-ámod chit ogyát chat táku sit oót-tapóncha man chit phyanúg-ka nang-āya sit aphít innókna uschit líang.

5. Unuchon chat tákū ot michatóngcha man sit philig; maíd máoi tai chopiyás on natáknang. Chuchóngyoncha chit iphil chit aphít ngato umya akit chit chóngyoncha. Masulít man chit mantá-tangáchancha, maíd chóngyonchas iphíl na. Mampaúlicha tai pasikónchan kínan chit phyanúg.

calves. There was nobody who could kill the eagle for the people were afraid.

2. On one afternoon there was a small child playing in the front-yard of a house. A delightful cool air was at the place where it played.

3. After a while the eagle saw the child in the yard. The eagle swooped down and snatched the child and flew away with it to the mountain.

4. When the child screamed, the eagle had already risen high. Excessive was the fright of the people when looking up at the eagle that had taken the child and carried it to the cave.

5. The people followed it and reached the mountain; it was impassable for it was very steep and high. They listened for the crying of the child above, but little was heard by them. After looking up for a while they did not hear its crying. They went back for they thought it had been eaten by the eagle.

1. *Phophóyoi* village, group of houses; from *phoyói* house.
iníngkāu, past of *ingkāu*, finding one's self, staying, being.
phyanúg probably the large, monkey-eating eagle, *Pithecophaga jefferyi* Grant, found on Luzón, Samar, and Mindanao. The Ibaloi of Benguet have a similar story of this bird called by them *saragmá* and found there only in the foothills.
mang-āyas from *mang-āya* one getting+*s*.
2. *Aphít* small child, baby.
3. *man* (probably *ma*+*n*, compare later *mat* from *ma*+*t*) seems to mark the progress of events.
chapyótonat from *chapyóton* object of snatching+*na* its+article *t*.
4. *naāphús* expresses finished action.
ngummato, past of *ngumato* from *ngato* above+infix *um*.
oót-tapón; imper. *otapóm* let (it) be the object of thy looking up; past *intap*.

6. Mawakás ot umói chit amāna mantangad manumphús; nagngoi nat akit-ta iphíl chit ánakna. Namingsāna chingngoina. Nampaúli chit amāna tai achína naka-āya sit ánakna. Chakkói-ya phyaphyáwinan chit kaisan tai adsāna na-íla chit ánakna.

7. Maphitil man chit aphít maíd mangai-ánas kanōna tai maíd apoi ya maíd phināyu. Maphítil mana-únai, nangan sichat inayan chit phyanúg-ka ugsa onno phoyók.

8. Makaduan phūyan ot chummakkói chit aphít ot chummachakkói pai chat upphūn chit phyanúg. Oyóg man chat upphūn tumaud chinomchom chit aphít on man-āyan.

9. Ot osán phigphikát man kaisan chit inan chat upphū. Postōna chit ikin chat upphū ot ilāyugna chicha. Ot inámammāam chit aphít-ta niphíanat sit pīta. Ichāyana chat chūan upphū sit phophóyoi.

6. The following day the father went to look up again; he believed to hear some little crying of his child. He heard it only once. The father went back for he could not take his child. Great was his sorrow on going away for he had not found his child.

7. The child was hungry, but there was no getting any food because there was no fire and no rice. Being very hungry it ate from the prey of the eagle which was deer or pig.

8. After two months had passed the child had grown bigger and also the young of the eagle had grown up. As the young eagles were able to fly the child thought of going away.

9. Then, one morning, the mother of the young eagles flew away. The child tied the legs of the young to use these for descending to the ground. And slowly the child sank down to the earth. It took along the two young eagles in going back to the village.

5. *unúchon* object of following.
michatóng, possibly from **maichatóng*.
maíd máoi not passable.
chuchóngyon, probably a progressive form of **chongóyon* obj. of listening.
pasikón object of thinking; past *pinasíg*.
kínan, past of *kanón* object of eating.

6. *umói* one going; we would expect the past *ummói*, but this tense appears to be far from being regularly employed.
manumphús: our adverb "again" appears as a verbal form auxiliary to *mantangad*.
nagngoi a form said to denote one who believed to hear.

7. *inayan* what was taken (by the eagle).

8. *oyóg* seems to express the idea of enough, sufficient.

10. Sumáai man chit aphít naschá-au chat tákū tai pasikónchan natói. Natayók chat amāna ya susūnudna tai sumáai.

11. Mangwá man chat tákū nangwáchas sīlib. Iphyā-udcha chat ćhūan upphū sit pawai ot sukāoncha. Masulít manchi iníngkāu chingngóichan kas phyálin nampáipo sit kinófyat. Chumakko-chakkói chit anūnong an chingngói chat tákū ot lumókwas man si phyanúgka manánap sichat upphūna.

12. Maílana man chat upphūna manippókoi-yot chapiyótona chat upphūna sit sūka ot manokúyoscha chit tákū ot patáyoncha. Insangapatóicha chat chūan upphūna. Maáphús chiyot maíchon ogyātan chat tákū. Naaphús.

10. When the child arrived at home, the people were startled for they had thought it dead. Its parents and brothers and sisters rejoiced over its arrival.

11. The people decided to use a trick. They bound the two eaglets on the yard and planted sharpened sticks in the ground around them. They had been there a while when something like the rushing of wind was heard by them which came from the forest. Louder grew the sound which the people heard, and what appeared was the eagle looking for its young.

12. When it saw its young, it shot down to snatch them from among the sharpened sticks, and then the people rushed to the place and killed it. Together with it they killed the two eaglets. And thus was ended at last the fear of the people. Finished.

PHYAIPHYAYÁSANG
(Phulayāyau)
SACHA CHANGATAG KA CHA KÁAG

1. Sat osán ai-aikāu Si Changatag ud Saitan ummói ud

BALBALÁSANG
(Phulayāyau)
CHANGATAG AND THE MONKEYS

1. On a certain day Si Changatag of Saitan went to sell

9. *kaisan* was said to be the past of *manayan* one going away.
postón object of tying, past *pinsot*.
ilāyug with the help of which one descends; instrument of descending.
inam-ammaan, an auxiliary verbal form expressing the idea of "slowly" and being in the same (past) tense as the principal verb *niphíanat*.
ichāyan (probably from *chāyan* road, trail) what is taken along.

11. *mangwá* includes such meanings as: make, think, say, decide, etc.; past *nangwá* (contained in *nangwáchas*).
iphyá-ud, cf. Ilk. *ibalud*.

12. *maíchon*, from *maíd* there is not, and suffix, *on*, indicating direct object.

nanlako si kūsi. Kinimātana chit chuan phokói-ya kūsi on ina ingīna si lūwang úschin phophóyoi ud Photlok.

2. Ingkāu man sichit kawan chit kinúfyat iníngkāu chat kāag sit chāyan. Ot umíllong yān tai naphyanikói sit iningkawán chat kāag on inīlana.

3. Masulít manót ayāna chit phyató-wot pit-óngonat osán kāag. Masulít manót umachú cha chit kāag sit kāyu on manischung kan sía.

4. Paiyán ayánat osán phyató-wot pit-óngona c h i c h a. Auní manót lumsá chat chūan kakuúphyanchan ummói kan sía. Sinóngpatna chicha.

5. Maphyayág manót naámin nilúmsa chat iníngkāu sit kāyu on manokuyus kan sía ot maliglikót.

6. Iníngkāu ud achāyoma līang uschit ikid chit chayan. Tinainána chit áwit nan kūsiyot phumtík sit liang-ngot

jars. He carried suspended from a pole on his shoulder a couple of jars which he went to sell for a water-buffalo in the town of Photlok.

2. When he was in the middle of the forest there were monkeys on the road. And he just sat down for rest as he was tired, at the place where there were the monkeys he had seen.

3. After a while he took a stone and threw it at a monkey killing it. Thereupon the monkeys became many on the trees and they peered down upon him wistfully.

4. Again he took a stone and stoned them. After that there came down two of their leaders who went at him. He cut them down.

5. After a while all of them that were in the trees came down and rushed upon him and he became excited.

6. There was a deep cave at the side of the road. He left the load of jars and ran to the cave and many were also the

1. *kinimāta;* a means of carrying loads is by a pair of baskets, *kimāta,* suspended from the extremities of a pole, *aséu,* carried over the shoulder; *mangimata* one thus carrying a load; *kimatáon* what is thus carried.
   phokói a classifying auxiliary to numerals used to count globular things such as jars, demijohns, coconuts, etc.
   ingīna si lūwang; also *ingīnat lūwang* might be said; *lūwang* is the *nuang* of other northern dialects.
2. *kawa middle,* Isin. *gawa.*
   kinúfyat forest, cf. Tag. *gubat.*
   umíllong one resting; *yān* meaning "just."
3. *pit-óngonat: pit-óngon* object of stoning (Past *pinit-ong*) + *na* his + *t*<*si.*
   man-ischung, cf. Bont. *umuschung* one looking down watching.

achūn únai chat kāag-ka metón-ud kan sía; umya iníngkāu phyáchangnan anchu.

7. Ipainókna chit potód na sit līang; pasawāyona chit áwakna on mampatói sichat kāag-ka mamatói kan sía. Awad pai nilumnok sit aphút tinogmānat óyuna.

8. Achū man chit pinatóina on sachat kāag nangwachas sīlifcha. Ummói chat úchūm sit tongod chit līang-ngot kuyūphyanchat tongod chit phyató.

9. Na-amin pai chat kāag sit sauphían chit līang nisukat chat sumasāyum. Maphyayág manót sachat kāag-ka iníngkāu sit tongod chit phyató lummosphūcha sit chayom chit līangngot sa chiyon tinilíucha on Si Changatag-kot iphusnágcha ot mapoipoitóyancha ingkánas maicha únai ud maiwayang sit phukásna.

10. Sa chiyon naichon Si Changatag ta kinan chi kāag sit cháyana inóina. Naāphús.

monkeys who followed him; however, he had with him his long bolo.

7. He put the lower half of his body into the hole, stuck out his waist, and killed the monkeys who wanted to kill him. Whenever one entered the hole he cut off its head.

8. Many were those killed by him when the monkeys used a stratagem. Some of them went to the back of the cave and dug a hole at the back of the rock.

9. When the monkeys at the entrance of the cave were all exterminated many others came to replace them. After a while also those monkeys who were at the back of the rock passed through to the interior and thereupon caught hold of Si Changatag who was dragged out by them and torn to pieces until no more was left of his flesh.

10. Thus perished Si Changatag bitten to death by the monkeys on the road which he had traveled. Finished.

4. *sinóngpat*, past of *songpáton*, object of cutting down.
6. *tinainan*, past of *tainan* what is left.
phumtik one running, past *phinumtik*.
7. *tinógma*, past of *togmáon: togmáok* my object of cutting off.
8. *sīlifcha* their trick; the last sound of *sīlif* is a very slender fricative.
9. *tinilíu*, past of *tiliwón* what is seized.
10. *kinan meaning* generally "eaten" but also "destroyed."
inói, past of *ayon* what is passed, as a road walked over.

PHYAIPHYAYÁSANG
(Pattékyan)

SACHAT IPHUĀYAN NANGÁYAU UD PATTÉKYAN

1. Sat osán ai-aikāu iníngkāu chad Iphuāyan nangáyau ud Pattékyan. Awád kad chatón tákūn nampáipod Phuāya tóyumpūyu cha ot limá.

2. Umachanícha man ud Pattékyan umillóngcha yān ta mangancha ta payót naphīlogchan makapatoi si kancha.

3. Umya lamóng ot tai iníngkāu osán layākin Ipattékyana ummói mangāyu-wot awád kadton ina nangayúwan siat kapongāton chit umillongan chat phūsoi.

4. Ot mampokpok man sit awitónan káyu iníngkāu chad tumotolíng-nga chingngóina ot manischung man chopyá iníngkāu chad mankakāna tákū.

5. Nakítak si ogyátna ta sachit os-ossáan osyá. Mangwá si sīlip ot ok-óyona chit chakkóya phyató-wot itopákna man chopyá nipuntá sit káwachan chat phūsoi on mankakán.

BALBALÁSANG
(Patikían)

THOSE FROM BUAYA GO ON A HEADHUNT TO PATIKÍAN

1. On a certain day there were men from Buaya going on a head-hunt to Patikían. As for those men come from Buaya they were thirty-five.

2. When they came near to Patikían they sat down to rest a while and to eat in order to be strong to fight, as they said to themselves.

3. However, there was a man from Patikían who had gone to cut wood and as for the place to which he had gone to cut the wood it was just above the resting place of the enemies.

4. And while cutting his load of wood there were the sounds of talking people heard by him and when he looked down wistfully there were people who were eating.

5. Excessive was his fear for he was quite alone. He used a stratagem: he picked up a big stone and dropped it downhill hitting the place where the enemies were eating.

1. *nangayau*, past of *mangayau* who goes headhunting.
nampáipo, compare: *Nampaipuam?* Where do you come from?
2. *umachaní* one approaching, past *ummachaní*.
naphílog who or what is strong; a form with prefix *ma* does not exist.
kancha means primarily "they say" or "said" but probably also "they thought."
3. *tai, also pronounced tɛi* or *tɛ*.
Ipattékyana, the final *a* is the connective particle.
nangayu from *káyu* wood.
kapongaton, for *kapangaton?*

6. Otchākona man chit phyató pinachisanānan nangkolís; impákoinan: "Mangói kayón uchúm lákūd ta salewángammin uchúm chaya!" Ot namphubtik chat phūsoi ta kancha nu achūn tákūn manchogchog kan chicha. Awāchoppai osossáan chit layākin nan-og-ogyát kan chicha.

7. Ot awád kadchatón phūsoi inamínchan tinainan chat kochónga alikāmoncha ta sāchit nakiyatánchan nákig-tót osyá. Asúg-ka kanon cha naámin niwális.

8. Ot mapotīpot man chat phūsoi nisukat chit layāki ot aminōnan ubpōnon chat kochónga tináinancha, ot mampaúlid phophóyoi, on umói mangaya si phuyonan man-áwit sichat uyos, kamán, tōpyai kan cha kayāsag on tinóponna.

9. Sumāai phophóyoi chiyot iphyakānas chat susúnudna. Umōlicha ot ináminchan ināya chat kochónga alikāmon chat phūsoi ot kod-kodwáoncha chat ināyacha.

6. In dropping the stone he made at the same time a big noise shouting: "Some of you pass down river and we others get around them from up river!" Then the enemies started to run thinking that many men were pursuing them. And there was left alone the man who had scared them.

7. As for the enemies they left behind all their things for he had put them immediately into a fright. Their provision of boiled rice was all scattered.

8. When the enemies were hardly gone he entered the place they had left and piled up all the things abandoned by them and then he returned to the village to fetch his companions as carriers of those blankets, head-axes, spears, and shields which he had piled up.

9. Arrived at home he told his relatives of the affair. They went back and took all the belongings of the enemies and distributed their booty.

4. *tumotolíng*, compare *tumling* who talks noisily; past *tinumling*.
chingngói, past of *chongngōyon*.

5. *ok-óyon* what is lifted, past *inók-oi*.
nipuntá, past of *mipuntá* (possibly from **maipuntá*), compare Span. *apuntar* to aim at.
káwachan may have to be analyzed into *ka*+*awad*+*an* place of finding oneself.

6. *otchākon* what is dropped, past *inótchak*.
impákoi past of *ipakoi* what is shouted.
salewangammi from *saleu-ángan-mi* object of our surrounding, past *sinaleu-ángan*.

10. Ot sumāai man chat phūsoi sit phophóyoicha maichaúnai insáaicha tai natainan chat kochónga alikāmoncha. Imphyág-phyakáchas chat kailíanchan: "Nasúyagchan tákūd Pattékyan ta ichakami inafót" kancha.

11. Sia chiyot kochóngchan umoi mangáya-wón ud Pattékyan ta natīlogcha. Achícha inum-ummói ud Pattékyan ingkāna si sumāai chat Melikánon umói mampaāmod kalingká. Sansāton maid mamphuphūsoi ta naámin ummāmon tákū.

10. And also the enemies arrived at their village bringing with them absolutely nothing for they had left behind their entire outfit. What they told to their villagers was: "The people of Patikían are brave for we were met by them," they said.

11. This, then, was the end of their going head-hunting to Patikían for they were scared. No more did they go to Patikían until the Americans arrived who came to tame the Kalinga. At the present time there are none warring with each other for they are all tamed people.

7. *tinainan*, past of *tainan* what is left behind.
kochóng all without remainder, all to a finish; cf. Bont. *kœchœng chí* this is all, Inib. *nákcheng* finished.
alikāmon equipment, personal belongings.
nakiyatan has the sense of "having done immediately."
nakig-tót, past of *makig-tót* who frightens.
asúg boiled rice, with following connective *a: asúg-ka;* in rapid speaking *asúka.*
8. *mapotīpot* what has all but disappeared.
nisukat, past of *misukat* what takes the place of something else.
aminōnan probably *amin* all + *on* object of direct action + *na* his + *n* connective, the whole being adverbial to *ubpōnon;* past *inamin; ubpōnon* what is put on top of something else, past *inubpon.*
uyos cotton blanket, Inib. *ulœs.*
9. *ināya*, past of *áyon* what is taken; *Ayam nat lapis!* Take that pencil!
kod-kodwāon object of distributing, past *kinod-kodwá;* probably from radical *duá* two: *kad-kaduá-on*, the change from *a* to *o* not being seldom.
10. *maichaúnai* apparently from *maíd* nothing + *a* connective + *unai* expressing a high degree, as "at all" in nothing at all.
inafót, past of *aptón* what is met.
11. *mangáya-wón* from *mangayau* + *on.*

SAʌOGSOG
(Pfūʌo)
SE AʌUKƎNA KÉNNAN CHIT PFUŒYƎ

1. Osán laphí inummói Se Aʌukəna Ipinokpok namungwít se ikan ot opatchœt kennâna. Ot anchímana kœwœen chi laphí manchukchuk-ʌōp kanô-wot nasū-yop set ikid chit chenúm.

2. Anchin kœwœen man chi laphí inī-nau chit pfuœ̄yə ot tumakchang chet pfuœ̄yə ot chinukmā-ana chet oʌpon Aʌukən ot illāyugnat chet kaachaʌœman chet chenúm ta picœōna no kanōna Se Aʌukən.

3. Nomycœ Se Aʌukən naphīlog ot anchímana il-lók chet pfuœ̄yə set liyang inawítna chet pfuœ̄yə ot intákchannat chit taʌantag.

4. Anchímana píllimaón chet pfuœ̄yən il-lók sichit chuʌom kummāpuyón Se Aʌukən ta achū chet phikœd set long-agna.

SALEGSEG
(Bolo)
SI ALUGAN WHO WAS BITTEN BY AN ALLIGATOR

1. On a certain night Si Alugan went to catch fish with a hook and four were caught by him. When it became midnight he became sleepy, it is said, and he slept at the edge of the water.

2. About midnight he was scented by the alligator and the alligator came out of the water going to the shore and caught hold of Alugan's leg and jumped with him into the deep of the water because it wanted to devour Si Alugan.

3. But Si Alugan was strong and when the alligator was already dragging him into a cave (under the water) he lifted it and went with it to the shore.

4. When the alligator had already sunk him five times into the deep Si Alugan became weak for many were the wounds on his body.

Title. Aʌukən, the form *Alugan* was said to be that given this name in Pinokpok, a town on the lower Saltan.
Se, chit, pronounced also *si, chet;* I show the fluctuation by writing the vowel just as I heard it; *ch* in *chit* and other words often sounds almost like *ds;* except before *œ* (as in *chœ*) where it approaches *dʒ*.

1. *namungwit,* compare Tag. *bingwit,* Bont. *fengwit* fishhook.
kennan was stated to be the past of *kon-on* object of catching, different from *kénnan,* past of *kanón* object of eating.

2. *inī-nau,* past of *inawón* object of smelling.
tumakchang one going from the water to the shore; past *tummakchang.*
chinukmā-an, past of *chukmā-on* object of seizing.
illāyug, past of *ilāyug* with what one jumps down.

5. Anchímana adyán-dyanín matói kenawótna chet attán chet pfuœ̄yə ot nilipsûtan chet pfuœ̄yə ta masikœbœn set attâna.

6. Ot nilipsútana Se Aʃukən-not manâyan set ɖuɖóʃoina nomyə achína makâkuə ta masâʃom chet phikœdna.

7. Anchímana lumáos makatlo ummói chit pfuœ̄yə inínap chet innói Aʃukən ot inchasana chit nai-ângon chœ̄ʃan Aʃukən. Ot siyə inúnu-únod nan inínau chet innóina. Ot chinatóngna chet ɖoʃoi Aʃukən ot nansóyok set choya.

8. Nomyə anchímana lumíkna Se Aʃukən nanchit nasû-yop chingngóʃna chet pfuœyə mantattá-oʃ ta piœ̄ənan payau-on Se Aʃukən.

5. When he was almost dead he dug his fingers into the eyes of the alligator and the alligator let him free for its eyes caused it great pain.

6. When Si Alugan was set free he went to his village but he could not walk for he had many wounds.

7. When three nights had passed, the alligator went to search for the road taken by Alugan and found it by the dried blood of Alugan. And it followed the smell of his track. And when it reached the house of Alugan it hid itself in the space under the floor.

8. But when Si Alugan awoke from his sleep he heard the alligator snorting for it wanted to cause him to come out.

3. *il-lók*, past *inillok*, what is caused to enter.
inawît, past of *awîton* what is carried as a load.
intákchan, past of *itákchan* what is taken from the water to the shore.

4. *pillimaón*, radical *limá* five; it appears herefrom that prefix *pi* (*piŋ?*) and suffix *on* are used to form with cardinal numbers derivatives indicating how often something is done.
long-ag whole body; *g* with nasal resonance.

5. *adyen-dyəní* almost, Ilk. *ngan-nganí*.
kenawót, past of *kautón* (from **kawoton?*) what is put into.
attá eye; note formation of genitive after noun ending in vowel: *attán chet pfuœ̄yə* eye of the alligator; compare genitive after noun ending in consonant: *ikid chet chənûm* edge of water.
nilipsútan, past of *lipsútan* object of letting go.
masikœbœn what is very painful.

6. *makâkuə* one able to walk, say, do.
masaʃom what is numerous.

7. *makatlo*, the word "night" is evidently understood.
charʃa blood, Inib. *chala*.

8. *payau-on* what is caused to come out, past said to be *pinayâ-uə*.

9. Pfummāngon Se Aʌukən-not ayāna osán chakkóʌa dŭatówot itup-úgna chet telid chet pfuœ̄yə ot phinumtek set ikōuna.

10. Ot anchímana manchat-chatóng chet pfūyon Aʌukən set man-u-úkūdchœ ta piœonchœ no patayónchœ chet pfuœ̄yə.

11. Ot manchat-chatóngchœ man yɛ achūchœ ot kananchœn: "Oʌóg takón patayón ta achū takó." Ot inummóichœ set ikōuna ot kummūʌubchœ se achœʌum-ma phito set ikid chet chənúm set sog-ón chet ikōuna.

12. Maāpfus chet phiton kingwœ̄chœ ot pfunpfunanchœt set tūpfun chet kāyu. Maāpfus chīyot ichœyanchœ chit osán āso-wot ipápanchœt chit phitu.

13. Ot anchímana mantá-ūʌ chet āso chingngoʌ chet pfuœ̄yə ot manūchak chet pfuœ̄yə ta ina kanón nomyə naknát chit phītu. Ot pinatóichœon chet pfuœ̄yə. Nagangpōton.

9. Si Alugan got up and took a big stone and hit the back of the alligator which ran away to its lair.

10. And then the neighbors of Alugan came together to talk for they wanted to kill the alligator.

11. And when they assembled they were many and they said: "We are sufficient to kill it for we are many." So they went to its lair and dug a deep hole at the edge of the water beside its home.

12. When the hole was finished which they had made they covered it over with the leaves of trees. This done they went to get a dog and used it as bait in the hole.

13. And when the dog barked it was heard by the alligator and the alligator ran to go and eat it but was caught in the hole. And then they killed the alligator. Finished.

9. *ayan* object of taking, past *ináya*.
itup-ug object of throwing, past *intup-ug*.
ikōu (also *ikāu*) dwelling-place.

11. *sog-ón*, generally used as a preposition meaning "near:" *sog-ón chin doʌoi* near the house (if house is in view; otherwise *sog-ón chit doʌoi*).

12. *kingwœ* (from * *kinwœ?*), past of *kau-on* what is to be made; radical possibly *kuá*.
ipápan what is used as bait, past *nipápan; papánan* the place where a bait is used.

13. *nakná*, past of *makná*, what is caught (in a hole or on a hook).
pinatóichœon and *nagangpōton:* the final *on* in both expressions is probably equivalent to Iloko *en*, meaning "already," in such expressions as *nalpás aminen*, all finished already.

SAʌOGSOG
(Ka-wong)

UG-ÚKŪD KAN LUMĀWIG

1. Se Lumāwig na kawasāna kaphīlas maíd kanōna; hachē-chit amāna yə ināna natóichœn naāmin.

2. Hachēchit kaāma-án Lumāwig kaīna-ána yə kakāping-sana issánchœ Se Lumāwig it-chən se kanōna; ot chumakōʌ man Se Lumāwig ummói set úchūm-ma dudóʌoi ummōtang se pillák hichēchit úchūm-ma tákū ta tuʌtuʌlian na chichœ. Hachit chœkup chit inōtangna nasuʌōk-ka chūen gasōt-ta pē-sus.

3. Ummói man chēchit tákū imusón chit pillákchœn inōtang Lumāwig; kanānan: "Aunī yan ta īyak man-īla se pillák se maʌakpús kotnat pillák-ka inō-tangko ken chakayó." Ot ma-dœyəg manón kawœsa maíd ochasāna si pillák se mamdē-yədna chēchit ōtangna.

4. Osán laphí man ummói Lumāwig inākau chit pfuyón chœ dœyug on napnō se apōn-got. Ot hāchit pottóg chit apōngot ta inākau Lumāwig kan ud dœyug tuʌung gasōt-ta pēsus. Ot hāchit apōngot im-dēyəd nan amin sed chēchit ōtangnat chēchit úchūm-ma tákū.

SALEGSEG
(Ka-wong)

THE STORY OF LUMAWIG

1. Si Lumawig was absolutely destitute and had nothing to eat. Those parents of his were all dead.

2. The uncle of Lumawig and his aunt and cousins would not give him any food and when he grew up he went to other villages to borrow money from some people to whom he told lies. The total of his debt exceeded two hundred pesos.

3. When the people went to ask for the money which Lumawig had borrowed he said: "Just wait, for I shall go and find the money to pay back that money which I borrowed from you." And for a long time after he absolutely could not find money to pay his debts.

4. On a certain night Lumawig went and stole the treasure-basket of the Bayug family which was full of beads. And the value of the beads stolen by Lumawig from Bayug was three hundred pesos. And the beads he used as a means to pay all his debts to the other people.

1. *hachēchit*, the same as later *hichēchit*, *hāchit*, is sometimes pronounced with *s* for *h* (*sachœchit*, etc.); the majority, however, is said to repudiate this as incorrect; for *œ* compare notes to Salegseg phonetics in the introduction.

2. *issán*, expressing unwillingness, adverbial to *itchən*; past *inissan*. *itchən*, one to whom is given, past *initchən*; *mangitód* one who gives.

5. Se ɖœyug ummói sichit ɖoʌoi Lumāwig ta ina chongʌon chit nang-aʌ-an ud Lumāwig set apōngot-ta namɖœ̄yəd-nat chet pillák-ka inōtangnat chœ̄chit úchūm-ma tákū.

6. Ot imusón man ɖœyug kan Lumāwig: "Sinnot nang-aʌ-am chit apōngot-ta nam ɖœ̄yədnot chœ̄chit pillák-ka inōtangnot chœ̄chit úchūm-ma tákū?" kanán man ɖœyug.

7. Ken-āwat Lumāwig: "Ot uāk; no picœom umói ka ichəʌom kan kuphín-nachól." Ot ummói ɖœyug inchəʌom sichit kuphín-nachól chet apōngot-ta inākau Lumāwig ot Se Kuphín-nachól ina impa-āʌa chet nanākau chœ̄chit pōlis.

8. Isaaʌ man chœ̄chit pōlis Se Lumāwig sinumāʌan chet kuphín-nachól ot nampudnu Se Lumāwig kan kuphín-nachól-la: "Sākón chit nangākau set apōngot chœ ɖœyug." Ot impa-ichœʌan kuphín-nachól Se Lumāwig se chœ̄chit pōlis ud Pfuntok ot inníngkœ̄chœ chet kansél.

5. Si Bayug went to the house of Lumawig in order to inquire about the place where Lumawig got the beads with which he paid the money he borrowed from the other people.

6. Then Bayug asked of Lumawig: "From whom did you get the beads with which you paid the moneys you borrowed from the other people?" said Bayug.

7. Lumawig replied: "They are mine; if you like go and report it to the governor." And Bayug reported to the governor the beads stolen by Lumawig and the governor ordered the police to arrest the thief.

8. Si Lumawig was brought by the police to be examined by the governor and he confessed to the governor (saying:) "I am the thief of the beads of the Bayug people." And the governor caused Si Lumawig to be conducted by the police to Bontoc and they put him into jail.

3. *imusón* what is asked for, past *inimús*.
kotnat probably contracted from *ko* my and *sanat* that.
4. *inākau*, past of *akáwon* object of stealing.
chœ ɖœyúg (Ilk. *da Bayug*) the Bayug family, the Bayugs.
im ɖœ̄yəd, past of *iɖœ̄yəd*, means of paying.
5. *nang-aʌ-an*, past of *mang-aʌ-an* place where, or person from whom, something is obtained; *Si Pedro mang-aʌ-ak si taɖœko* Pedro is my purveyor for tobacco.
namɖœ̄yədnat, final *t* is an enclitic form of *si* (*hi*), likewise in following *inōtangnat*.
6. *sinnot* from *sinno si*.
namɖœ̄ʌədnot, the possessive suffix of the second person singular is *no*, not *mo*.
7. *uāk* from *uá* property + *ko* mine.

9. Ot maʃakpús man osán chəkūn sinumāʃan koēs Se Lumāwig ot nakuœ̄ chet lasón Lumāwig ot impaʃūpfus koēs. Ot imɗœ̄kán Lumāwig kan koēs-sa achí man-ākau paí-yón ot ken-áwat koēs-sa: "No man-ākau-ka paí-yón ikansélme paí-yón seka ingkœnat matói-ka." Ot kaʃsán Se Lumāwig set ílina.

9. When one year had passed he was examined by the judge and he gave explanations and was set free by the judge. And Lumawig told the judge that he would not steal again and the judge replied: "If you steal again we shall put you into prison until you die." And Si Lumawig went away to his town.

10. Ot in-kāu man set ílina nan-ākau paí-yón ot mangwœ̄ mat kapitán chœt Ilemus ɪna inchəʃom Se Lumāwig ot pinaʋʃa kuphín-nachól Se Lumāwig hichœ̄chit pōlis ot chumatóng man Se Lumāwig sinōmāʃən chet kuphín-nachól ot masulít manón nampudno Se Lumāwig ot kanānan: "Ŏn, nan-ākawák" ot painnigkən kuphín-nachól Se Lumāwig set ɗoʃoi chœ̄chit suʃchœcho ot imɗœkœn chet kuphín-nachól no chuən pōʃon aʃaʃkau ichœʃanchœ ud Pfuntok.

10. And when he found himself in his town he stole again and the capitan of the people of Lemus decided to go and report Lumawig and the governor caused the police to arrest him and when he arrived he was examined by the governor and by and by Si Lumawig confessed and said: "Yes, I have stolen," and the governor ordered him put into the house of the constabulary and the governor said that after twenty days he be conducted by them to Bontoc.

8. *sinumāʃa*, past of *sumāʃa*, very probably from Span. *sumária* first examination in court.
impa-ichœʃan, past of *pa-ichœʃan*, cf. *ichāyan* in notes to sect. 9 of The Eagle and the Child.
Pfuntok, for a number of years after the advent of the American régime, the Kalinga towns whose speech is here recorded formed part of the present subprovince of Bontoc.
innígkœ, past of *igkœ* what is put into something.
kansél, from Span. *cárcel* jail.

9. *chə́kūn* year, Iban. *dagun;* the above statement is evidently due to an error; the rights of an accused person are well established under American law all over the Islands.
koēs, from Span. *juez*, judge.
nakuœ, past of *makuoé* one saying, doing.
lasón, from Span. *razón* reason.
imɗœkœ, past of *iɗœkœ̄* what is told; cf. *iphyaká* in Bal.

11. Ot osán laphí man kanán Lumāwig-kœ: "Iyak umispfō" ot in-kauchœ man set lasín inā-yan Lumāwig chet ɗœchœ̄ng-ngot songpātonat takʌai chet suʌchœcho. Ot mangwœ̄ mat suʌchœcho inchongpaʌnat ɗœ-yonēta set pfūáng Lumāwig ot natói.

12. Ot mangwœ̄ man chœ̄chit pfuyón Lumāwig ichœ innāya lachoégna ot inchœʌanchœt chit ílichœ ot pa-īsan chœt Lumā-wig se chuən pfuoʌ-ʌok. Lum-máus mat chuən aʌ-aʌkau in-nilɗon chœt Lumāwig.

11. And one night Lumawig said: "I go to make water," and when they were outside Luma-wig took a bolo (cleaver) and cut into the arm of the soldier. And the soldier responded by sticking his bayonet into the stomach of Lumawig who died.

12. And the town-mates of Lumawig decided to go and get his body and to transport it to his town and they killed two pigs at his funeral. When two days had passed they buried Lumawig.

GINÁANG

UG-ÚKUDJ CHAT MAN-ÁMA NAGCHAYAN

1. Chat man-aáma tuyu na-pángugcha. Ináikau chi áikau incha man-iwá-ai sit payáu.

2. Sit osán ai-áikau ummoi-cha nan-iwá-ai sit payau-wot íngkāucha pon sit payau um-muchan-not man-iwá-aicha.

3. Sit amācha man-iwá-ai sit tuppíng, sit phuphyā-i man-iwá-ai sit sag-ón-na, sit layá-i man-iwá-ai sit phi-ik.

GINÁANG

THE STORY OF THE FATHER AND CHILD BURIED BY A LANDSLIDE

1. The father and his two children were diligent workers. Day after day they went to work in the rice-field.

2. On a certain day they had gone to work in the rice-field and finding themselves in the field the rain fell, yet they worked on.

3. The father was working near the stone-wall, the daughter (lit. woman) worked by his side, and the son (lit. man) on the other side (of the field).

10. *payən* again, Bal. would use here *umphós*, with same meaning.
mangwœ̄, cf. *mangwá*, in notes to sect. 11 of The Eagle and the Child.
Ilemus the people of the town of Lemus (Limus) on the Saltan east of Salegseg.
suʌchœcho from Span. *soldado*, here applied to members of the constabulary.

11. *songpāton* what is cut, past *sinúngpat*.
inchongpaʌ, past of *ichongpaʌ* instrument of sticking into.

12. *pa-īsan* who is made the recipient of the funeral honors consisting in the slaughtering of two pigs; the souls of the animals are supposed to accompany the deceased who is thus appeased and kept from making trouble for his bereaved friends.

4. Sat man-iwa-áyancha inîngkāu ngas-ngās-sa nataknáng ot mangwá mat ūchan pinachagson-nat pīta ot magchái chit ngas-ngās ot matab-ūnancha.

4. At the place where (the former two) were working there was a steep slope which was very high, and as the rain had made the soil heavy, the slope collapsed and buried them.

5. Ot sit layá-i chingngoi chit nagchaí-yot mantuwíli pon sichát amāna an sunúdna naidcha pon ot ummói pon umachaní nagchayáncha ot man-īphil ot chongyon man chat uchūmma tákū inī-moscha an siya.

5. When the son heard the slide he turned to look for his father and sister who were no more there and he went to approach those who were buried and he cried and he was heard by the other people who asked him.

6. Ot iphyakānan nagchayán chat amāna an sunúdna ot sit tákūn na-ngimús nampaói ot umāli chat tákū sit ili. Ot chummatóng man chat tákū annan maniíyung chit layá-i.

6. And he told them that his father and sister were buried and the people who had asked shouted and the people from the town came. And when the people arrived there was the son crying.

7. Ot phya-úngancha ot ayáncha chichá. Ot ayancha man chichá natákucha. Ot phulíkancha phuphyā-i ya amāna sit phuphōyoi.

7. And they dug for them and got them. And when they got them they were alive. And they carried the woman and her father to the town.

Title. *man-áma* a term used to designate a group consisting of a father and his child; if there are two or more children *man-aáma* is said; note added *tuyu*, three, indicating the number of persons comprehended in the group. (Sect. 1)
inagchayán, past of *magchayán* who is caught in a landslide.

1. *incha* went-they, past of *icha* go-they.
inaikau, the second *i* is the sound represented by ʎ in Sal.

2. *ummúchan*, past of *umúchan* it rains.

3. *tupping* the stone-wall supporting the next higher rice-terrace.
sag-ón, cf. *sog-ón* in note to sect. 11 of story of Si Alugan.

4. *pinachagsón*, past of *pachagsonón* what is becoming heavy.
pīta earth, soil.
magchái what collapses, past *nagchái*.

5. *naidcha pon: naidcha* not-there-they, *pon* seems to be added to make the statement more impressive after the manner of Ilk. *met*.
an siya to him, compare *kan sía* in sect. 3 of Changatag and the Monkeys.

8. Ot chat uchūm-ma iníng-kāu sit ili áncha gai-ya: "Patói!" Ot naámmin chat tákū ummói sit nagchayán.

9. Ot imūsóncha pon: "Phoómpon si patói?"—yot ipa-áuáscha gai ilán chit nagchayán. Ot sit amácha na-alīwong-ngot man-u-úkudj chat apingsan-na ot patoyónchat opāt-ta phoyōk ta isichán chat tákūn nanchat-chatóng.

10. Ot nagamputcha pon nángan aisáncha. Ot naánai liman phuyan pon naíd chit mansīkab sichat nagchayán.

11. Ot ilapōcha paiyan-nat ináikau chi áikau man-iwá-ay tai pia-ónchat chit magamput chit payáu ta asíyot matói chit mayong-ág.

12. Ot chuan phuyan chit issāpon man-íllong chit amá. Na-alīwong si opāt-ta phuyan ot matói. Ot man-u-úkūdchat a-pingsan-na ot patoyónchat opāt-ta luang ta isichánchat tákū-wot chuan ai-áikau pon inilphoncha ot mangwácha si phoyoi sit lap-át chit lophón.

8. And the others who had stayed in the town just said: "Killed!", and all the people went to (see) those who had been buried by the landslide.

9. And they asked: "Not killed?" and passed on just to have a look at those buried by the landslide. And the father was sick and his cousins talked together and they killed four pigs for food of the people who had arrived.

10. And when they had finished eating they went away. And it took five months to cure the pains of those buried under the landslide.

11. And they again began to work day by day for they wanted to finish the rice-field before the old man died.

12. And for two months the father did not take a rest. He was in bad health for four months and then he died. And his cousins talked together and killed four water-buffaloes as food for the people and after two days they buried him and made a house over his grave.

6. *sunúd* brother or sister.
anna, probably a deictic expression similar in force to French *voilà*.
7. *phulíkan*, past *phinulíkan*, compare Ilk. *bulígan* what is carried between two.
8. *áncha gai* said-they just, cf. Ilk. *konada laeng;* Gin. *áncha* = Bal. *káncha*. *ya* after *gai* is connective particle *a* plus consonantal initial drawn over from *gai*.
9. *isichán* any boiled food taken with rice; preferentially meat.
10. *nagamput* or *nagangput* finished; pronounce *na-gamput*.
naánai was said to be the past of *umánai* what is sufficient.
11. *pia-ón* object of liking, past *pinia*.
mayong-ág old man; the *y* of this word is the sound represented in Sal. by *ʎ*.

13. Ot sit asāwan chit natói issāpon lumāwa si simphūyan. Ot sit payáu chit natói nampayáu chit anákna.

13. And the wife of the dead man did not go out for one month. And the rice-field of the deceased became the rice-field of his children.

TINGGIAN (ITNEG) OF ABRA (PEÑARUBIA)

MEPANGGEB TA ITNEG DI ABRA

1. Ítnœg ta kasigúdan na tā-o di Abra. Dad kōdil dangi kiūti kan dad búok dangi atáddo kan nangísit.

2. Daddi babāi-yē agikkuāda ta batek aglikmót kandi ulo, ima kan daddi tengnged dangi; ket daddi lalāki-ē agikkuāda ta ayābong aglikmót kandi ulo dangi, kan barikœs kan baál aglikmót kandi sikœt dangi kan agsaklitda ta immoko kandi barikœs dangi.

3. Daddi lugak dangi naappía nga kāpas ket abuénda payēn daddi lugakda nén. Daddi ayābung dangi ma-appía nga ukes ta mālit-í kāyo.

ABOUT THE ITNEG OF ABRA

1. The Itneg are the original people of Abra. Their skin is brown and their hair is long and black.

2. The women put on beads around their heads, hands, and necks, and the men put a turban around their heads, and a girdle and gee-string around their loins, and they suspend the short bolo from their belts.

3. Their clothes are made of cotton and they weave also their clothes themselves. Their turbans are made of bark of the balete tree.

12. *issāpon man-íllong* did not rest; it appears that while Gin. uses *issá* as a negative particle in connection with verbal forms (*issáak pon man-íllong* I do not rest, *issacha pon lumāwa* they do not go out), Bal. uses instead *achi* (almost *adzi*): *umachik, umachika, umachina umíllong* I do not, thou doest not, he does not rest; in Sal. texts we find: *achina makākuə* he could not walk, and *issánchœ itchən* would not feed.

phoyoi sit lap-át chit lophón, this probably ritualistic structure is known by the special term *bagong* and was said to be destined to protect the grave against rain.

1. *kasigúdan* origin, beginning, birth, thus *kasigúdan na tā-o* may also mean "native people."

2. *agikkuāda* put-they, compare Ilk. *ikuá* what is put in some place.

baál gee-string, Ilk. *baág*.

sikœt loins; the mixed vowel in this word, as in *ítnœg, barikœs*, is short and similar to the one in French *neuf;* when long, it resembles *eu* in French *peur*.

4. Agyanda ta ābong nga na-appía nga kāyo, kawayan, kan gōlon. Unnég nid ābong dangi oad ta kál-ang nga na-appía nga lota. Ket sidiœ nga kál-ang uad ta ta-lo a úlona nga nagsasángo kœt dublēna ta agtugawāna nidi bangá-ngœ.

5. Ket no bolan ta ukop, kíang kan ladau aga-apoida kandí dud-duagan dangi kœt aga-anīdoda œdœng ta adí lumtau di init-tē. Ket agtotogauda kandí likmót nidi apoi-yē.

6. Kœt no madátngan ta bolan ta manabá mangrugída nga aguangœl kandi kab-kabasáan danín. Kœt daddi lalāki-yē daida ta agarado kan agpailid; kœt daddi babāi-yē daida ta agoto ta kánenda kœt mapánda ibaōnanda dad asawa dangi no mamatóon. Kœt no malpás ta panagróecœp ta págei daddi babāi-yē agabōda ta lugak kœn ōwœs. Kœt daddi mœt lalāki-yē mapánda agayoan ta nūang, baka, kabāyo, kan īyas.

4. Their dwellings are houses built of wood, bamboo, and cogon grass. Inside of their houses there is a fire-pot made of clay. And that fire-pot has three heads which bend toward each other and this is the sitting-place of the cooking-pot.

5. And during the months of December, January, and February they will make fire in front of the houses and warm themselves while the sun does not rise. And they are sitting round the fire.

6. And when there has arrived the month of May they begin to work in their irrigated rice-fields. And the men they plow and harrow, and the women they cook their food and they go to provide their husbands with food at noon-time. And when the planting of the rice is finished, the women weave clothes and blankets. And also the men go to take care of the buffaloes, cows, horses, and pigs.

4. *unnég nid*, also *unnég nidi* is said.
kál-ang, Tag. *kalán* the typical Philippine utensil, consisting in a heavy, wide-open, flat fire-pot of clay on the flat floor of which the fire is kindled and on whose upper rim three projecting points are bent inward so as to serve as supports for the superimposed cooking-pot.

5. *dud-duagan*, cf. Ilk. *duag* roof over entrance to house.

7. Kœt no madátngan ta panaglaāni, nga dublēna ta bolan ta ukop, agkakalsōda, daddi babāi-yē nga mapánda aglaāni; kœt daddi mœt lalāki-yē daida ta agbetek kan agbónag-ga agyódong kadad pāgei-yē.

8. Kœt no malpás ta laāni ikuāda daddi pagei dangi kandi báang dangi ta sannon malāngo. Kœt no malāngo di pāgei nin, ipasakáida kandi ālang danín.

9. Kœt kalpásan datoe nga maappía rugīandan ta agappía kadādi an-ánnongda nga annáwid. Kœt no oad ta masakít kadaida agbaláwada oenno agpal-lāanda ta sannon malaíngan di masakít-tē oenno pakawanēna nidi nangkaro dóbli nangi.

10. Ket dato Itnœg-ē naggagítda mœt nga aguangœl. Nalaéngda mœt nga agibaón kadaddi anak dangi nga agadal.

11. Adū pai lāmeng ta annáwid ta Itnœg. Nœm adiák mībaga nga lisán ità.

7. And when comes the time for harvesting the rice, which is the month of December, they go to the fields, the women in order to cut rice, and the men, on their part, they bundle and go to and fro carrying home that rice.

8. And when the cutting of rice is finished they put the rice in stacks in order to dry. And if the rice is dry they lift it up into their granaries.

9. And after this work they begin to make their ceremonies which are customary. And if there is a sick person among them, they have the ceremony called "balawa" or the lesser ceremony called "pal-lāan," so that thus may get well the sick person, or that he may be freed from his malady (by the grace of him who caused it through his evil influence).

10. And the Itneg are also industrious as workers. They are likewise intelligent enough to send their children to study.

11. Many more yet are the habitual occupations of the Itneg. But I cannot relate them all now.

The personal and possessive pronouns in Tinggian, Balbalásang, Salegseg, and Ginúang.

PERSONAL PRONOUNS IN INDEPENDENT AND POSTPOSITIVE FORM.

Singular.

	Tinggian.	Balbalásang.	Salegseg.	Ginúang.
First person	diaken, -ak	sakon, -ak	siak, -ak	sa-on, -ak
Second person	dika, -ka	seka, -ka	seka, -ka	si-a, -a
Third person	(dublina)	siya	siya	siya

Plural.

First person inclusive	ditai, -tayo	chitako, -tako	chita-o, -ta-o
First person exclusive	dikame, -kame	chakame, -kame	chi-ame, -ame
First person dual	ditá, -ta	chitá, -ta	(si-a sa-on) -ta
Second person	dikayó, -kayó	chakayó, -kayó	chi-ayú, -ayú
Third person	daida, -da	chichá, -cha	chichá, -cha

POSSESSIVE SUFFIXES.

Singular.

First person	ko, -k	ko, -k	o, -k
Second person	mo, -m	no, -m	no, -m
Third person	na	na	na

Plural.

First person inclusive	tayó	tako	ta-o
First person exclusive	mi	me	me
First person dual	ta	ta	ta
Second person	yo	yo	yu
Third person	da	cha	cha

ILLUSTRATION

TEXT FIGURE

FIG. 1. Map of the subprovince of Kalinga. 207

NOTES ON JAPANESE LEPIDOPTERA AND THEIR LARVÆ: PART VI *

By A. E. WILEMAN

Of Dorking, England

TWO COLORED PLATES

HETEROCERA

SATURNIADÆ

Genus SAMIA Hübner

Samia cynthia Drury.

Plate 1, fig. 1, larva, third ? stage; fig. 2, larva, fourth ? stage; figs. 3 and 4, larva, fifth ? stage, dorsal and lateral aspects; fig. 5, larva, sixth ? stage; fig. 5*a*, food plant. Larva of *Samia pryeri*. Japanese names: *Shinju-san; aya-nishiki; mikazuki.*

Phalæna cynthia DRURY, Ill. Exot. Ent. 2 (1773) pl. 6, fig. 2; KIRBY, Cat. Lep. Het. (1892) 748; LEECH, Proc. Zool. Soc. London (1888) 634, No. 255; Trans. Ent. Soc. London (1898) 264, No. 4; HAMPSON, Moths Brit. India 1 (1892) 16; MOORE, Lep. East. Ind. Co. (1859) pl. 20, figs. 3, 3*a*; NAWA, Insect World (Konchū Sekai) 10 (1906) 366, pl. 9, larva, pupa, imago ♂; MATSUMURA, Cat. Insect. Japan (1905) 47, No. 383; Thousand Insects of Japan [Nihon Senchu Dzukai (Jap.)] (1909) suppl. 1, 40, No. 65, pl. 6, fig. 1, ♂; JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911) 212.

Attacus walkeri FELDER, Wien. Ent. Mon. 6 (1862) 34; Jordan, Seitz's Macrolep. Faun. Pal. 2 (1911) 212.

Attacus pryeri BUTLER, Proc. Zool. Soc. London (1878) 388; Ill. Typ. Lep. Het. 3 (1879) pl. 43, fig. 5; PRYER, Trans. Asiat. Soc. Japan 12 (1883) 53, No. 196; SASAKI, Insects Injurious to Japanese Trees [Nihon Jūmoku Gaichūhen (Jap.)] ed. 3 (1910) pt. 3, 74, pl. 198, larva, cocoon, imago ♀; JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911) 213, pl. 33, fig. a, ♂.

Jordan [1] describes the larvæ and pupæ of the genus *Samia* as follows:

Larvæ powdered with white; with six rows of fleshy thorns, which bear sparse bristles, the dorsal processes longer than the lateral ones in the earlier stages, later on the difference smaller. Cocoon long, pointed at both ends, usually wrapped up in a large or several small leaves. Pupa without bristles at the anal end.

* The editors have been unable to verify the quotations in this article.

[1] Seitz's Macrolep. Faun. Pal. 2 (1911) 212.

Two species, one of which is confined to India while the other occurs from Japan to India and eastward to the Sula Islands, and is also acclimatised in several localities in Europe and North America.

Jordan describes the larva of *Samia cynthia* Drury as follows:

Larva at first yellowish, then white or greenish or bluish green, with black dots; the dorsal processes in the later stages about as long as the distance between two dorsal processes of the same segment; the processes of the different segments almost equal, bluish. Polyphagous, chief food-plants: Ailanthus, Ilex, etc.; prefers Syringa in Europe, but also takes Prunus, Pirus, Laburnum, and other plants. The cocoon consists of an outer layer of loose silk and an inner dense web. The silk, from which a very tough cloth is made, cannot be reeled, but is carded and then spun. It is coarse and not valuable for export. True cynthia Drury is confined to the Malayan districts. On Palearctic territory two forms are found: pryeri Butl. (33a) inhabits Japan. The proximal band of the forewing more or less convex posteriorly, without long teeth on the median veins, the discal band twice deeply incurved, only faintly reddish outside the white line, at least the red line is never sharply defined; on the hindwing the discal band is deeply incurved below the half moon. The cocoon is grey or yellowish white. The larvæ (tscho-san) are found especially on Ilex rotunda,[2] Ailanthus glandulosa and Phellodendron amurense.[3] The specimens from North and Central China, walkeri Fldr., are distinguished from pryeri by the discal band of both wings having a sharper outer edge and by the long median teeth of the proximal band of the forewing. This form goes northward to Manchuria and Corea, and is much kept domesticated for the sake of its silk, e. g. in the provinces of Shantung and Chekiang. This form was introduced into Europe in 1845 and has been domesticated in France with some success. In the Northern districts the species has only one brood, in the Southern countries several broods in a year. The second species of the genus, S. lunula Walk., is likewise easy to breed, and crosses between it and S. cynthia are also known.

Jordan gives the name *tscho-san* to the larva of *pryeri*. I have never heard this name. "Tscho" is certainly not Japanese but may be Chinese and probably refers to *walkeri* Felder, which occurs in China. The imago is known under the Japanese names of *shinju-san* (which name is probably given because the larva feeds on *shinju*), *aya-nishiki*, and *mikazuki*, "new moon," referring to the crescent on the wings.

The larva of *Samia pryeri* Butler is figured in what I believe to be the third, fourth, fifth, and sixth stages (Plate 1, figs.1 to 5). A brood of young larvæ was taken about September 15, 1900, at Kobe, Settsu Province, Honshu, on *kusagi* (*Clerodendron tricotomum*. Thunb.), one of which was selected to be

[2] *Ilex rotunda*, named in Japanese *fukura-shiba* and *kurogane-mochi*.
[3] *Phellodendron amurense*, named in Japanese *kiwada*.

figured in its various stages. This larva was figured in the third ? stage (Plate 1, fig.1), on September 19; in the fourth ? stage (Plate 1, fig. 2), on October 1; in the fifth ? stage (Plate 1, fig. 3, lateral aspect; fig. 4, dorsal aspect), on October 9; in the sixth ? stage, when it measured 66 millimeters in length, on October 26, 1900 (Plate 1, fig. 5). This larva and the rest of the brood were nearly all full-grown by October 26, but they all failed to develop imagoes after pupation as they were infested by the larvæ of an ichneumon fly. Several specimens of this fly emerged from the cocoons of *Samia pryeri* in April, 1901, and another emerged on June 27, 1901.[4]

A male imago was bred from a larva of *Samia pryeri* taken at Yoshino, Yamato Province, Honshu. This larva pupated in October, 1900, and the imago emerged on June 15, 1901. I also bred a specimen at Kobe, Settsu Province, Honshu, in August, 1901. Other food plants of the larva are maple, *momiji* (*Acer palmatum* Thunb.), and plantain, *bashō* (*Musa basjoo* Sieb.).

Nawa gives the following notes on *Attacus cynthia* Drury:

The larva[5] feeds upon *shinju* [*Ailanthus glandulosa* Desf.]; *nurude* [*Rhus semialata* Murr. var. *osbeckii* DC.]; *konzui* [Latin name unknown, not given by Matsumura in his Shokubutsu Mei-i]. The body, head and ventrum are pale yellow; pale indigo, fleshy tubercles on each segment which are clothed with a white flourlike substance.

The larva and the imago appear twice in the year. The first brood of the imago emerges about June or July, the second brood about September, or October. The larvæ which emerge from the second brood, when full grown, spin their cocoons and hibernate in the pupal stage, the imago emerging at the commencement of the following summer, when the ova are then deposited.

I find that in the final stage of the larva the white powder on the tubercles disappears. It seems to appear after the third ? stage when the larva turns from yellow to white.

Sasaki[6] gives descriptions and figures of the larva, cocoon, and imago of *Attacus pryeri* Butler (*Attacus cynthia* Drury) and a short record of its life history. He says:

The larvæ emerge from the ova about middle or end of June, and are full-grown by the end of July. The imago emerges about the commencement of August and deposits ova which hatch in about three weeks at

[4] This ichneumon fly has been identified by Claude Morley, Entomologist 43 (1910) 11, as *Pimpla luctuosa* Smith, Trans. Ent. Soc. London (1874) 394.

[5] The larva figured by Nawa measures 72 millimeters.

[6] Insects Injurious to Japanese Trees [Nihon Jūmoku Gaichūhen (Jap.)] ed. 3 (1910) pt. 3, 74, pl. 198.

the end of September when the second brood of larvæ appear. These larvæ are full grown by the end of October when they pupate and hibernate in the pupal stage, their imagoes emerging at the commencement of June of the following year. The ova deposited by these imagoes generally hatch in eight or nine days.

Pupa.—The pupa is contained in an elongated, brown cocoon, broad at the bottom and tapering above, which is made of extremely tough silk. It is suspended by a long, tough silken fiber to the bough of a tree, somewhat in the same manner as the cocoon of *Rhodinia fugax* Butler.

Local distribution.—Honshu, Musashi Province, Yokohama, July (*Pryer*): Musashi Province, Tokyo, July and August (*Wileman*). Kyushu (recorded by Leech, and my collector has gathered cocoons there). Matsumura records the species from Honshu, Shikoku, and Kyushu.

Time of appearance.—Larva, June to July, September to October; imago, June to October.

General distribution.—*Samia cynthia*, Malayan districts; *S. pryeri*, Japan; *S. walkeri*, northern and central China, Manchuria, Korea. (*Jordan.*)

Genus RHODINIA Staudinger

Rhodia MOORE, Proc. Zool. Soc. London (1872) 578 (nom. præocc.).
Rhodinia STAUDINGER, Rom. Mém. Lép. 6 (1892) 327.

Rhodinia fugax Butler.

Plate 1, fig. 6, larva, fifth ? stage; fig. 7, larva, sixth ? stage; fig. 8, paired dorsal tubercles on segment 4; fig. 9, tubercles on segments 11 and 12.

Japanese names: *Usutabi-ga, yama-bishaku, yama-kamasu, ajima-nishiki, yama-biku.*

Rhodia fugax BUTLER, Ann. & Mag. Nat. Hist. IV 20 (1877) 480; Ill. Typ. Lep. Het. 2 (1878) 17, pl. 26, fig. 1, ♂; PRYER, Trans. Asiat. Soc. Japan 12 (1883) 52, No. 193; LEECH, Proc. Zool. Soc. London (1888) 633, No. 251; STAUDINGER, Rom. Mém. Lép. 6 (1892) 327; LEECH, Trans. Ent. Soc. London (1898) 268, No. 13; STAUDINGER and REBEL, Cat. Lep. Pal. 1 (1901) 126, No. 1027; MATSUMURA, Cat. Insect. Jap. 1 (1905) 47, No. 386; NAWA, Insect World [Konchū Sekai (Jap.)] 10 (1906) 277, pl. 8, larva, pupa, imago ♀; MATSUMURA, Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1909) suppl. 1, 41, No. 66, fig. 2, ♂; SASAKI, Insects Injurious to Japanese Trees [Nihon Jūmoku Gaichūhen (Jap.)] ed. 3 (1910) pt. 2, 43, pl. 95, ova, larva, pupa, cocoon, imago ♂; JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911) 213, pl. 34, *c*, ♂, ♀; WILEMAN, Trans. Ent. Soc. London (1911) 344, No. 327.

Saturnia diana OBERTHÜR, Bull. Soc. Ent. France VI 6 (1886) 47; STAUDINGER and REBEL, Cat. Lep. Pal. 1 (1901) 126, No. 1027*a*; JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911) 213, pl. 34, *c*, ♂, ♀.

The larva figured (Plate 1, figs. 6 and 7) was taken in May, 1901, at Hiyeizan, near Kyoto, Yamashiro Province, Honshu, on dwarf oak (*Quercus serrata* Thunb.), Japanese name *kunugi*. It was figured on May 29 after its fourth ? molt (Plate 1, fig. 6) and again on June 23 after its fifth ? molt (Plate 1, fig. 7). It pupated on June 27, and a male imago emerged, which I identified at the South Kensington Museum as a dark form of *Rhodinia fugax* Butler.

Nawa [7] records the life history of *R. fugax* Butler and gives a figure of the larva after its sixth molt, of its pendant cocoon, and of the female imago.

Sasaki [8] also gives descriptions and figures of the ova, larva, pupa, cocoon, and male imago. He says that—

* * * the larvæ emerge from their ova at the end of April and feed upon dwarf oak, nara [*Quercus glandulifera* Bl.] and dwarf oak *kunugi* [*Quercus serrata* Thunb.]. They are full-grown by the end of June and the imagoes emerge at the end of October or commencement of November when the female oviposits.

Jordan [9] describes the larva, cocoon, and pupa of the genus *Rhodinia* as follows:

Larva almost naked, granulose, the six warts of the prothorax separated, but the two dorsal ones close together, the dorsal warts of the metathorax the largest, segment 11 with one dorsal wart instead of 2. Cocoon egg-shaped, but truncate at the upper end, and attached to a leaf or slender twig on one side so that the cocoon appears stalked at one corner (pitcher-like), dense, without outer loose silk. Pupa attached by the hooked bristles, which are placed close together, to a loosely woven transverse wall, which stands close to the apex of the cocoon. The full-grown larva as well as the pupa makes a loud chirping noise when disturbed. Distributed from the Himalayas to Amurland and Japan.

The following description given by Nawa of the larva of *Rhodinia fugax* in its various stages has been translated by me from the Japanese text:

On emergence from the ovum.—The head and segment 1 black; segment 2 and all the others light yellow; a black mediodorsal line; body clothed with black hairs.

Three or four hours after emergence from ovum.—The dorsum becomes almost entirely black; laterally yellow.

After first molt.—The larva becomes yellow below the subdorsal line; black-haired tubercles appear on the body.

[7] Insect World (Konchū Sekai) 10 (1906) 277, pl. 8.

[8] Insects Injurious to Japanese Trees [Nihon Jūmoku Gaichūhen (Jap.)] ed. 3 (1910) pt. 2, 43, pl. 95.

[9] Seitz's Macrolep. 2 (1911) 213.

After second molt.—The black dorsal area becomes yellow, and the lateral yellow becomes black; the tubercles which have greatly increased in length are arranged as follows: Segments 1 and 12, four tubercles each; segments 2 and 11, six tubercles each; segment 3, two dorsal tubercles; segment 11, one dorsal tubercle; below the spiracles on segments 2 and 11 the tubercles are blue, each emitting four or five black spines.

After third molt.—The whole body becomes pale yellowish green and occasionally there is a black lateral stripe.

After fourth molt.—There is no change whatever.

After fifth molt.—The larva loses all the long spined tubercles, with the exception of the two dorsal tubercles on segment 3 and the one dorsal tubercle on segment 11. At this stage the larva, when alarmed at any thing, makes a noise something like the sound of "chū."

After sixth molt.—When full grown the larva is greenish yellow; ventrum bluish green; a subspiracular stripe above which there is on each segment one small blue tubercle; two longer dorsal tubercles on segment 3, the mediodorsal shorter tubercle on segment 11 still remains; the posterior margin of all segments paler in color; on the dorsum and body there are minute warts. When full grown it spins a green cocoon the upper end of which has a hole which seems as if it had been cut out in a circle; the cocoon is suspended by a thread attached to its upper angle and hangs down from the branch. The larva emerges from the ovum in April and feeds on *nara*, [dwarf oak (*Quercus glandulifera* Blume)]; *kunugi*, [dwarf oak (*Quercus serrata* Thunb.)]; *kuri*, [chestnut (*Castanea vulgaris* Lam. var. *japonica* DC.)]; *kashi* [*Quercus acuta* Thunb.].

It pupates at the end of June or beginning of July, and the imago emerges in October or November. The female deposits its eggs on the twigs of the tree or on the cocoon and they hatch in April as previously stated. The imago is single-brooded.

The larva as figured by Nawa measures about 87 millimeters. According to Matsumura it also feeds on *keyaki* (*Zelkowa acuminata* Lindl.) and *kashiwa* (*Quercus dentata* Thunb.). Pryer gives cherry and other trees. Jordan gives *Phellodendron* which, if it be the same as the Japanese species (*Phellodendron amurense* Rupr.), is called *kiwada*.

The following description of the larva is taken from my original figures:

After fourth ? molt.—Plate 1, fig. 6; figured, May 29. Length, 54 millimeters. Head light green; body apple green; ventrum, all legs, prolegs, and claspers darker green, speckled with minute yellowish spots; spiracles brownish; a yellowish white, subspiracular line; paired, spinous, dorsal tubercles on segments 2 to 13, those on segment 2 (next to the head) being blue; the tubercles on segments 4 and 12 are longer and more prominent than the rest; a spined, midlateral, blue tubercle on segment 2; a series of subspiracular, spined, blue tubercles on

each segment from 2 to 12; two, spined, blue tubercles on the anal segment 13, above the subspiracular series; one spined, blue tubercle above each thoracic leg, below the subspiracular series; all the spined tubercles of segment 2, those of the anus, those of the subspiracular series, and those above the thoracic legs are blue; all the rest are green.

After fifth molt.—Plate 1, fig. 7, figured, June 13. Length, 64 millimeters. Segment 2 edged with yellow; body and head lighter in color, inclining to greenish yellow; ventrum as before; subspiracular line not so prominent; all the spined tubercles have disappeared with the following exceptions: There still remain long, spineless, paired tubercles on segment 4 and a single, shorter, spineless tubercle on segment 12; also the subspiracular series is represented by a spineless blue wart on each segment from 2 to 12 and by similar spineless, blue warts above each of the three thoracic legs. The dorsal and anal series of spined tubercles, which have disappeared, are represented by small yellow warts. My original figure of the larva agrees with those given by Nawa and Sasaki.

Cocoon.—The large, thick-ribbed, yellowish green cocoon, shaped, as Staudinger observes, something like a pitcher, is suspended from the twig of a tree by a stout silken thread, which Staudinger says measures from 10 to 30 millimeters in length. There is a hole at the bottom of the cocoon; and the top, which is slit longitudinally, opens to pressure. It mimics a pendant leaf, and when the leaves have fallen from the trees in winter it is quite a conspicuous object, easily perceived by any person walking through the woods. The larva and the pupa, as also stated by Jordan and Nawa, make a chirping noise, which somewhat resembles the creaking of a bough; and the sound made by the pupa, so I am informed, can be distinctly heard at some little distance even in the woods. It makes this sound on being touched, but it also appears to make it of its own accord, when suspended by its cocoon in the woods.

The Japanese names given to this moth are based upon the shape of the cocoon: *Yama-bishaku,* or mountain ladle; *yama-kamasu,* or mountain straw bag; *yama-biku,* or mountain basket.

Local distribution.—Honshu, Musashi Province, Yokohama, November and December (*Pryer*): Musashi Province, Tokyo, taken and bred in October and November (*Wileman*): Settsu Province, Kobe, bred in October (*Wileman*). Matsumura records the species from Hokkaido and Honshu.

Time of appearance.—Ovum, April; larva, April, May, and June; pupa, June and July; imago, October, November, and December. Single-brooded.

General distribution.—Japan; eastern Siberia (Amurland, Ussuri, Suifun, Vladivostok, Askold). (*Jordan.*)

The type of *Rhodinia fugax*, a male in the British Museum collection, is from Yokohama. (*Jonas.*)

Genus CALIGULA Moore

Caligula MOORE, Trans. Ent. Soc. London 1 (1862) 321.

Caligula boisduvali Eversmann.

Plate 1, fig. 10, full-grown larva, fifth ? stage; fig. 11, food plant.

Plate 2, fig. 1, young larva, third ? stage; fig. 2, food plant; fig. 3, thoracic segments, dorsal aspect; figs. 4 and 5, median and anal segments, dorsal aspect. Larva of *Caligula jonasi* Butler.

Japanese name, *hime-yama-nai.*

Saturnia boisduvali EVERSMANN, Bull. Mosc. 3 (1846) 83, pl. 1, fig. 1; 7 (1847) pl. 4, fig. 5; HERR-SCHÄFF., Schmett. Eur. 6 (1849) figs. 148–150; OBERTHÜR, Ann. Soc. France (1886) 46 (larva); STAUDINGER, Rom. Mém. Lép. 6 (1892) 325; STAUDINGER and REBEL, Cat. Lep. Pal. 1 (1901) 127, No. 1031; LEECH, Trans. Ent. Soc. London (1898) 265, No. 6; MATSUMURA, Cat. Insect. Jap. (1905) 47, No. 387; Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1909) suppl. 1, 41, No. 67, pl. 6, fig. 3, ♀.

Caligula jonasi BUTLER, Ann. & Mag. Nat. Hist. IV 20 (1877) 479; Ill. Typ. Lep. Het. 2 (1878) 16, pl. 25, fig. 2, ♂; LEECH, Proc. Zool. Soc. London (1888) 633, No. 252; STAUDINGER, Rom. Mém. Lép. 6 (1892) 325; KIRBY, Cat. Lep. Het. (1892) 761; STAUDINGER and REBEL, Cat. Lep. Pal. 1 (1901) 127, No. 1031*a*; NAWA, Insect World [Konchū Sekai (Jap.)] 10 (1906) 191, pl. 5, imago ♀; SASAKI, Insects Injurious to Japanese Trees [Nihon Jūmoku Gaichūhen (Jap.)] ed. 3 (1910) pt. 2, 34, pl. 92, larva, pupa, imago; JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911) 218, pl. 32, *b*, ♂.

Caligula fallax JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911) 217; pl. 32, *d*, ♀ (as *boisduvali*) (subspecies *jonasi* = Stgr. pt.; *boisduvali* auct. pt.).

Caligula boisduvali JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911 217.

Two larvæ are figured. The young larva (Plate 2, fig. 1) was probably in the third ? stage, but no note was made of this at the time. This larva was taken at Hakodate, Hokkaido (Yezo), in June, 1902 (figured, June 24), on wild pear, *yama-nashi* (*Pirus* sp.).

The full-grown larva (Plate 1, fig. 10) was probably in the fifth ? stage, but no note was made of this at the time. This larva was taken in June, 1901, at Yoshino, Yamato Province, Honshu (figured, June 17), on dwarf oak, *kunugi* (*Quercus serrata* Thunb.). The pupa of this larva died, but I bred other

imagoes of *Caligula jonasi* from similar larvæ on September 21, 29, and 30, and October 1, at Hakodate. Pryer states that "the larva feeds on cherry and that it resembles a small Caligula japonica."

Staudinger comments on the larva of *Saturnia boisduvali* Eversm. (? var. *jonasi*), as follows:

> The yellow green (preserved) larvæ are covered with very short, bristly, yellow hairs, with a few, long, dark hairs, especially on the anterior segments. When young they have a broad, black, dorsal stripe with orange warts. They appear to differ a great deal, for Oberthür describes them in Ann. Soc. Fr. (1886), p. XLVI, as "black, with two red dorsal spots." They make a light lattice-like cocoon which resembles those made by the larvæ of *Saturnia caecigena*, with which they have some resemblance, and the moth appears, as in the case of *caecigena*, in autumn (September).

The six, paired, dorsal spots of my young larva of *Caligula jonasi* are red as described by Oberthür, not orange as described by Staudinger,[10] who, possibly, is speaking of the Amurland geographical form, subspecies *fallax* Jordan (not named by Jordan at the time the larva was described by Staudinger).

Nawa [11] states that—

> *Jonasi* hibernates in the ovum stage and the young larva emerges in May. The full-grown larva spins up and pupates, after the fourth ? or fifth ? molt is completed, about the middle of June and the imago emerges about the middle of October, when the female oviposits.
>
> The larva feeds on *nashi*, pear [*Pirus sinensis* Lindl.]; *ume*, plum [*Prunus mume* S. and Z.]; *keyaki* [*Zelkowa acuminata* Lindl.]; *midzuki* [*Cornus macrophylla* Wall]. At first it is black with tubercles on each segment which emit black and gray hairs; legs black; prolegs grayish yellow; when it grows in size the head becomes deep green and the body light green, dorsally tinged with white; the subspiracular line becomes light green; and the ventrum grayish green; spiracles chestnut color; the hairs of the subspiracular series of tubercles very long when full-grown.

Oberthür gives as food plants in Manchuria [? Amurland] *Betula; Prunus; Pirus baccata* Linn. [found and known in Japan as var. *manchurica* Maxim., under the Japanese names of *ko-ringo, beniringo, aka-ringo*]. Sasaki [12] gives descriptions and figures of the young and adult larva, cocoon, and male imago of *Caligula jonasi*. He says:

> The larva emerges about the month of June and feeds upon *ōnara*, oak [*Quercus crispula* Blume]; *gamazumi*, [*Viburnum dilatatum* Thunb.];

[10] Rom. Mém. Lép. 6 (1892) 326.

[11] Insect World (Konchū Sekai) 10 (1906) 191.

[12] Insects Injurious to Japanese Trees [Nihon Jūmoku Gaichūhen (Jap.)] ed. 3 (1910), pt. 2, 34, pl. 92.

kurumi, walnut [*Juglans* sp.]. It is full grown between September and October and the imago emerges by the end of October.

I describe the larva from my original figures as follows:

Young larva in third ? stage.—Plate 2, fig. 1. Length, 23 millimeters; light green; a broad diamond-pattern, longitudinal, black dorsal stripe with paired red tubercles emitting short, spinous black hairs on segments 3, 4, 7, 8, 9, and 10 (counting head as segment 1), paired black tubercles, with similar hairs on segments 2, 5, 6, 11, 12, and 13; subspiracular line lighter in color; head pale green, edged with black; spiracles dark; legs dark; prolegs and claspers green.

Larva in fifth ? stage.—Plate 1, fig. 10. Length, 65 millimeters. Body yellowish green, head of a darker shade; dorsum covered with short, bristly, yellow hairs with a few long, darker hairs interspersed amongst them; segmental sutures whitish; spiracles white, encircled with a ring of chestnut brown; subspiracular line yellowish; legs ochraceous; prolegs dark green; claspers yellowish green, with a long black dash at the base.

My original figure of the larva in the third ? stage agrees with that given by Sasaki. Jordan comments on *Caligula boisduvali* as follows:

> Larva green, above and below with a black-brown, longitudinal stripe, the warts of both dorsal rows reddish yellow, full-grown without stripes (always ?). On various deciduous trees. Cocoon reticulate. The moth in the autumn. From Lake Baikal to Japan in three geographical forms.
>
> Boisduvali Ersch. [=Eversm.], from Kiachta, Urga and the Kentei Mountains, southward of Lake Baikal * * *.
>
> Fallax [Jordan], subsp. nov. (Jonasi Stgr. pt.; boisduvali auct. pt.) (32d as boisduvali). * * * Distributed from Vladivostok, Askold, Ussuri to the Amur.
>
> Jonasi Butler (32b, d). * * * Japan, on the Main Island, [Honshu] in September. Two nearly full-grown larvae before me have no longitudinal stripe above or below.
>
> *Cocoon.*—The pupa is enclosed in a cocoon similar to that of *Dictyoploca japonica* but it is smaller and spun with finer mesh. It also resembles, as Pryer observes of the cocoon of *japoncia*, "the wire net in a cartridge."

Local distribution.—Honshu, Musashi Province, Yokohama (*Pryer*): Musashi Province, Tokyo, October and November (*Wileman*): Shinano Province, Oiwake, September and October (*Leech*): Shimotsuke Province, Nikko, September and October (*Leech*). Hokkaido (Yezo), Oshima Province, Hakodate, September and October (*Wileman*). Matsumura records *Saturnia* (*Caligula*) *boisduvali* from Honshu and Hokkaido.

Time of appearance.—Larva, May and June; pupa, June to September; imago, September to November; ovum, November to May.

General distribution.—From Lake Baikal to Japan. (*Jordan*).

Genus DICTYOPLOCA Jordan

Dictyoploca JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911) 218.

Dictyoploca japonica Butler.

Plate 2, fig. 6, full-grown larva.

Japanese names: *Kuso-san, tegusu-ga, kuri-kemushi, tsuzuri-no-nishiki, shiragata-rō, kurimushi-ga.*

Caligula japonica MOORE, Trans. Ent. Soc. London (1862) 322 (pupa case) (*regina* Stgr.); BUTLER, Ann. & Mag. Nat. Hist. IV 20 (1877) 479; Ill. Typ. Lep. Het. 2 (1878) 16, pl. 26, fig. 2, ♂; PRYER, Trans. Asiat. Soc. Japan 12 (1883) 52, No. 191; OBERTHÜR, Ann. Soc. Ent. France (1886) 48, larva; LEECH, Proc. Zool. Soc. London (1888) 633, No. 253; STAUDINGER, Rom. Mém. Lép. 6 (1892) 328; LEECH, Trans. Ent. Soc. London (1898) 264, No. 5; MATSUMURA, Injurious Japanese Insects [Nihon Gaichūhen (Jap.)] (1899) 75, pl. 32, fig. 1, imago ♂; STAUDINGER and REBEL, Cat. Lep. Pal. 1 (1901) 126, No. 1026; PACKARD, Proc. Am. Acad. Arts and Sci. 39 (1904) 564 (larva); MATSUMURA, Cat. Insect. Jap. 1 (1905) 47, No. 385; NAWA, Insect World [Konchū Sekai (Jap.)] 10 (1906) 63, pl. 3, larva, pupa, imago ♂; MATSUMURA, Thousand Insects of Japan [Nihon Senchū Dzukei (Jap.)] (1909), suppl. 1, 50, No. 82, pl. 9, fig. 1, ♀; SASAKI, Insects Injurious to Japanese Trees [Nihon Jūmoko Gaichūhen (Jap.)] ed. 3 (1910) pt. 2, 89, pl. 119, larva, pupa, imago ♂; SASAKI, Insects Injurious to Fruit Trees [Kwajū Gaichūhen (Jap.)] ed. 5 (1911) 216, pl. 70, larva, imago.

Caligula castanea SWINHOE, Cat. Lep. Het. Oxford (1892) 249; JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911) 218, pl. 32 *c*, ♂.

Dictyoploca japonica JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911) 218, pl. 32, *c*, ♂, ♀.

Jordan erects a new genus, *Dictyoploca,* for this species, which was formerly placed in *Caligula* Moore.

Genus DICTYOPLOCA Jordan

Forewing with only two subcostal branches. The distal segments of the antennae below more produced at the apex than in *Caligula*, and with more distinct sensory cones, the pectinations of ♂ shorter, the apical ones on the middle segments of the ♀ short but distinct. Larva at first black, with rows of warts clothed with black bristles, in the following stages: greenish yellow below, black above, clothed with long white hairs, then more or less completely white with blue spots at the stigmata, small black dots, and short transverse streaks laterally. Cocoon with much larger meshes than in *Caligula*. Pupa very rugate, apex of abdomen almost

truncate in a straight line, forming a sharp edge, on each side with a bundle of short bristles in a groove. The cocoons are used for the manufacture of silk, but both the quantity and quality are negligible. Himalayas to Japan.

Jordan [13] gives the following details concerning the imago and larva of *Dictyoploca japonica:*

D. japonica Butl. (regina Stgr.) (32*c*). Ground-colour varying, yellowish grey, brownish yellow, or almost olive; the markings on the contrary fairly constant. Forewing above in the basal fourth with a reddish or brownish transverse line which bounds a large basal spot, and with a second rather diffuse line beyond the middle which touches the ocellus at the outer side, or stands slightly distant from it; the area bounded by the two lines slightly lighter than rest of the wing; ocellus oblique. Hindwing usually redder than the forewing, with much larger and more sharply defined ocellus. Below more unicolorous than above; the ocellus on the forewing with black pupil, on the hindwing blind. Pale specimens are f. castanea Swinh. Larva on Juglans, Castanea, Camphora, in captivity takes Oak, Hawthorn, Willow, etc. The three first stages of the larva almost alike; in the fourth and fifth stages the black colour confined to the sides, the warts of the thorax with a few black bristles between the greenish white hairs. Meshes of cocoon large. Japan (Main Island and Kyūshū), Amurland, North China; the moth in the autumn (September and October), common. The silk glands of the caterpillar are sometimes employed for the manufacture of fishing lines.

The type of *D. japonica,* male, from Yokohama (*Jonas*) is in the British Museum collection. The larva figured (Plate 2, fig. 6) was taken in June, 1901, at Kobe, Settsu Province, Honshu, on *kunugi,* dwarf oak (*Quercus serrata* Thunb.). It pupated on June 27, and a female imago of the pale buff form emerged on a date unrecorded.

Packard [14] has described the larva at length, giving all the stages. Nawa [15] and Matsumura [16] record the life history and give figures of the ova, larva, pupa, cocoon, and male imago. Oberthür [17] also has described the larva.

Food plants.—The food plants are as follows, and probably several more should be included: *Ku-su-no-ki,* camphor tree (*Cinnamomum camphora* Nees); *kurumi,* walnut (*Juglans* sp.); *ringo,* apple, (*Pyrus malus* L.); *urushi,* lacquer tree (*Rhus vernicifera* DC.); *hakuyō,* poplar (*Populas alba* L.); *kusagi* (*Clerodendron tricotomum* Thunb.). The larva, however, is

[13] Seitz's Macrolep. Faun. Pal. 2 (1911) 218.
[14] Proc. Am. Acad. Arts Sci. 39 (1904) 564.
[15] Insect World (Konchū Sekai) 10 (1906) 63, pl. 3.
[16] Japanese Injurious Insects (Nihon Gaichūhen) (1899) 75, pl. 32.
[17] Soc. France (1886) 48.

found chiefly on *kuri,* Spanish chestnut (*Castanea vulgaris* Lam. var. *japonica* DC.), whence its popular name of *kuri-kemushi* or *kuri-mushi* is derived, equivalent to "chestnut caterpillar" or "chestnut grub" in English. Oberthür gives *Juglans mantschourica* as the food plant in Amurland.

Cocoon.—Pryer [18] remarks:

Commonly called the wire-cartridge moth, from the resemblance of the cocoon to the wire-net in a cartridge; last year, [1884], it was found feeding on poplars newly introduced into this country [Japan]. The natives make a strong coarse silk from the cocoon, and a fine gut from the intestines of the larva. Imago appears in October; larva hairy.

Nawa [19] gives the following description of the larva which, in his figure, measures about 60 millimeters, much smaller than mine, which measures 103 millimeters.

The larva at first is black and the head is covered with ashy white hairs; six small tubercles on each segment which emit long ashy white and black hairs; these become pale green when the larva grows bigger; head greenish yellow covered with pale yellow hairs; body pale green; the tubercles of each segment of the body emit long greenish white hairs, for this reason it is named *shiragata-rō;* spiracular stripe black; spiracles indigo-blue; subspiracular line yellow spotted with light red; ventrum dark yellowish green speckled with black spots; legs pale yellow; prolegs dark yellowish green and their extremities pale yellowish green. The cocoon is woven like a net and is commonly called *sukashi-dawara,* [or transparent rice-bag, because the pupa can be seen through the meshes.]

Sasaki [20] gives descriptions and figures of the larva, pupa, and male imago of *Dictyoploca japonica.* He says:

* * * the larva emerges between the end of April and commencement of May and feeds upon *hyakujikkō,* or *sarusuberi* [*Lagerstroemia indica* Linn.]; *kuri,* [Spanish chestnut (*Castanea vulgaris* Lam. var. *japonica* DC.]; *kusu-no-ki,* [Camphor tree (*Cinnamomum camphora* Nees)]; [*keyaki* (*Zelkowa acuminata* Pl.)]; *kurumi,* [walnut (*Juglans* sp.)]. It is full-grown between the middle of June and commencement of July and the imago emerges between the end of August and the commencement of October, when it oviposits.

Matsumura [21] records the life history of the species and gives figures of the male imago, ova, larva, and cocoon. He says that "in Hokkaido it is single brooded and hibernates in the ovum stage." The female deposits some three hundred forty or more

[18] Trans. Asiat. Soc. Japan 12 (1883) 52.

[19] Insect World 10 (1906) 63.

[20] Insects Injurious to Japanese Trees [Nihon Jūmoku Gaichūhen (Jap.)] ed. 3 (1910) pt. 2, 89, pl. 199, larva, pupa, imago; Insects Injurious to Fruit Trees [Kwajū Gaichūhen (Jap.)] ed. 5 (1911) 216, pl. 70, larva, imago.

[21] Japanese Injurious Insects (Nihon Gaichūhen) (1899) 75.

ova in two or three different places on the bark of the tree on which it feeds. The ova hatch in May or June of the following year. At first the larva is black; after the second molt white hairs begin to appear, and it is full grown in about forty-five days, when it makes a netlike cocoon, which is commonly known as *sukashi-dawara*. The imago emerges at the end of September, when the ova are deposited by the female in the manner previously indicated. The larvæ sometimes appear in such numbers that they do much injury to the foliage of chestnut and walnut trees, but this is profitably counterbalanced to some extent by the fact that a kind of catgut named *tegusu*, used by fishermen, is made out of threads contained in the body of the full-grown larva and finds a ready sale.

Local distribution.—Honshu, Musashi Province, Yokohama (*Pryer*); Tokyo, taken and bred September and October (*Wileman*): Shimotsuke Province, Nikko, October (*Leech*): Settsu Province, Kobe, September (*Wileman*). Kyushu, Kyushu (*Leech*): Hyuga Province, Kuraoka, September (*Wileman*). Shikoku, my Japanese collector, informed me that he had taken the species in Sanuki Province. Matsumura records it from all the Japanese Islands, Hokkaido, Honshu, Kyushu, Shikoku, and from Formosa (Taiwan).

Time of appearance.—Ovum, September and October; larva, April to June; pupa, June to September; imago, September and October. The imago emerges in September and October and then the female deposits her eggs on the bark of the trees and on twigs, which pass the winter without hatching. The young larvæ emerge in May of the following year. Single-brooded.

As has been indicated by authors previously quoted, a gut, named in Japanese *tegusu-ito*, is manufactured from the silk glands or the intestines of the full-grown larva. Those interested in this subject and in the manufacture of the coarse silk, also made out of the strong netlike cocoon, can find further details in several Japanese scientific journals.[22]

The following account of the manufacture of tegusu-ito is given by Sasaki.[23] He quotes an extract from a pamphlet, or

[22] Toba, Insect World (Konchū Sekai) 1 (1897) pt. 3, 92–94; Sasaki, Nihon Jūmoku Gaichūhen (Insects Injurious to Japanese Trees) ed. 3 (1910) 92; Sasaki, Dai Nihon Nōkwaihō (Bull. Jap. Agr. Soc.) (1905) No. 294, 15–18; Honda, Dai Nihon Sanshi Kwaihō (Bull. Jap. Sericult. Soc.) (1905) No. 160, 1–7; Honda, Dai Nihon Nōkwaihō (Bull. Jap. Agr. Soc.) (1905) No. 292, 3–11.

[23] Nihon Jūmoku Gaichūhen.

article, named "Kusumushi Yō hō," "the method of rearing camphor grubs," which is as follows:

Many persons have tried to manufacture "tegusu-ito" from the full-grown larvæ of the "kuri-mushi" (chestnut grub). The process of manufacture is as follows:

Full-grown larvæ which are just on the point of spinning their cocoons are selected. They are slit open and the silken threads extracted. These threads are then soaked in a solution made of vinegar, (of 35 per cent strength), pure water and a little salt. After that they are removed from the solution, stretched out and dried, and are now called "tegusu-ito." These threads are now soaked again in white rice water [which is the water resulting after washing rice, preparatory to cooking], for about one hour, after which they are taken out and dried. When thoroughly dry they are placed between walnuts wrapped up in layers of cotton cloth and gently rubbed. This imparts to them gloss and elasticity and a fine-looking "tegusu-ito" is the result.

It is to be presumed that fresh green walnuts are used, as without the outer green skin they would probably be too hard and uneven for this purpose.

Genus AGLIA Ochsenheimer

Aglia OCHSENHEIMER, Schmett. Eur. 3 (1810) 11.

Aglia tau Linnæus.

Plate 2, fig. 7, larva; fig. 8, head; fig. 9, extended transverse section of larva; fig. 10, food plant. Larva of *Aglia japonica* Leech.

Japanese name, *yezo-yotsume*.

Bombyx tau LINNÆUS, Syst. Nat. 1 (1758) 497; HÜBNER, Bomb. (1800) pl. 13, figs. 51, 52; STAUDINGER and REBEL, Cat. Lep. Pal. 1 (1901) 127, No. 1039; JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911) 224, pl. 35, *a*, ♂, ♀; 35, *b*, ♀.

Aglia tau var. *japonica* LEECH, Proc. Zool. Soc. London (1898) 632, No. 250; Trans. Ent. Soc. London (1898) 269, No. 16; STAUDINGER and REBEL, Cat. Lep. Pal. 1 (1901) 127, No. 1039 *c*; MATSUMURA, Cat. Insect. Jap. 1 (1905) 47, No. 388; Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1909) suppl. 1, 49, pl. 8, fig. 5, ♂; JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911) 224, pl. 35, *a*, ♂.

The larva figured (Plate 2, fig. 7) was taken in August, 1902 (figured, August 18), at Hakodate, Oshima Province, Hokkaido, on maple, Japanese name *momiji* (*Acer* sp.). A female imago of var. *japonica* Leech emerged from the resulting pupa on July 12, 1903.

Jordan [24] describes the larva, pupa, and cocoon of the genus *Aglia* as follows:

Young larvæ with two dorsal rows of warts, which are long and thorn-like on the pro- and mesothorax, on segment 11 only one such thorn, anal

[24] Seitz's Macrolep. Faun. Pal. 2 (1911) 224.

segment with a median thorn at the tip; laterally and dorsally numerous granules bearing small hairs; in the later stages the warts completely obsolescent, but the segments swollen transversely at the corresponding places. Cremaster of pupa sharp with curved bristles.

Cocoon loose, between leaves and moss or below the surface.

Jordan [25] describes the larva of *Aglia tau* as follows:

Larva green with light lateral stripes directed obliquely up- and backward, below the stigmata a light longitudinal line with a reddish edge, the line widened on segment 4 to form a black-centered spot. On deciduous trees especially Beech, Oak, Birch, etc. Pupa hibernates. Moth from March to June according to the locality, in the North later than in the South; the ♂♂ fly by day and are very restless, the ♀♀ remain on tree-trunks and on the ground. In the Central and Southern districts of Northern Europe, eastward to Japan; not in England and the Mediterranean countries.

Kirby [26] remarks:

The larva [of *Aglia tau*] is green, with five red spines when young, which it loses when full grown. It has yellowish-white oblique stripes on the side, running upwards and forwards, and a yellowish line on the sides, which is broadest on the 4th segment. It feeds on beech, lime and oak in June and July.

The original figure of my larva of var. *japonica* Leech agrees well with the description given by Jordan of *Aglia tau* Linn., but he does not give the number of the oblique lateral stripes which, in my larva, are seven in number and of a whitish color.

Poulton [27] remarks:

The larva of the European Tau Emperor (*Aglia tau*) has an eye-like mark which it can expose when attacked, but which is otherwise concealed. The appearance of the larva in its terrifying attitude is shown in fig. 58.

This larva is an example of the form of protective mimicry alluded to by Poulton under pseudaposematic colors.[28] In the figure of my larva (Plate 2, fig. 7) the eyelike spot on segment 5 does not seem to be fully expanded.

Local distribution of Aglia tau var. *japonica*.—Honshu, Shimotsuke Province, Nikko, May (*Wileman*). Hokkaido, Oshima Province, Hakodate and Jansai Numa, June and July (*Wileman*). Matsumura records var. *japonica* from Honshu and Hokkaido.

Time of appearance.—Larva, August; imago, May to July. In Hokkaido the larva pupates in September, and the imago emerges in July of the following year.

[25] Loc. cit.

[26] European Butterflies and Moths (1889) 125.

[27] The Colours of Animals (1890) 264, fig. 58.

[28] Vide Philip. Journ. Sci. § D 9 (1914) table 1, facing page 248.

General distribution.—*Aglia tau,* in the central and southern districts of northern Europe, eastward to Japan; not in England and the Mediterranean countries. *Aglia tau* var. *japonica,* Japan only. (*Jordan.*)

BRAHMÆIDÆ

Genus BRAHMÆA Walker

Brahmæa WALKER, Cat. Lep. Het. 6 (1855) 1315.

Brahmæa japonica Butler.

Plate 2, fig. 11, larva, fourth ? stage; fig. 12, food plant; fig. 13, head; fig. 14, head, enlarged.

Japanese names: *Ibota-ga* and *shokko-nishiki.*

Brahmæa japonica BUTLER, Ent. Month. Mag. 10 (1873) 56 (*mniszechii* Feld.); Ill. Typ. Lep. Het. 2 (1878) 17, pl. 26, fig. 3, ♂; PRYER, Trans. Asiat. Soc. Japan 12 (1883) 53, No. 194: LEECH, Proc. Zool. Soc. London (1898) 635, No. 257; Trans. Ent. Soc. London (1898) 270, No. 20; MATSUMURA, Cat. Insect. Jap. (1905) 48, No. 389; NAWA, Insect World [Konchū Sekai (Jap.)] 10 (1906) 415, pl. 11, larva, pupa, imago ♀; MATSUMURA, Thousand Insects of Japan [Nihon Senchū Dzukai (Jap.)] (1909) suppl. 1, 42, No. 68, pl. 6, fig. 4, ♀; SASAKI, Insects Injurious to Japanese Trees [Nihon Jūmoku Gaichūhen (Jap.)] ed. 3 (1910) pt. 3, 132, pl. 225, larva, pupa, imago; JORDAN, Seitz's Macrolep. Faun. Pal. 2 (1911) 228, pl. 35, fig. c, ♂.

Brahmæa mniszechii FELDER and ROGENHOFER, Reise Novara, Lep. 4 (1874) pl. 93, figs. 4, 5.

Brahmæa nigrans BUTLER, Ent. Month. Mag. 17 (1880) 110; WATERHOUSE, Aid 1 (1881) pl. 29.

Jordan [29] comments on the family Brahmæidæ as follows:

This group comprises about one and a half to two dozen of highly peculiar but very similar species. All are large and rather clumsy moths, with markings so characteristic that they at once catch the eye even in large and mixed collections. The wing is divided into an outer half traversed by ten parallel wavy lines, which on the forewing directly touches an often uniformly dark basal area, but on the forewing borders on a band which is sometimes modified at the inner margin to form an ocellus-like disc. The basal area of the forewing again contains a number of those peculiar parallel lines, which renders the scheme of markings so confusing, and the biological significance of which we do not yet understand. And as if even Nature could not carry out so complicated a pattern in all its details, we very often find among the Brahmaeidae unsymmetrical specimens in which one side bears sometimes one stripe more than the other, sometimes has the dots differently placed. Among a considerable

[29] Seitz's Macrolep. Faun. Pal. 2 (1911) 227.

number of otherwise very well developed B. japonica before me there is not one specimen the two sides of which agree in every detail.

The position of Brahmaea in classification has only changed in that it was sometimes placed among the Saturniids, sometimes among the Bombycids. The larvæ as far as they are known, when full-grown resemble huge larvæ of silk-moths but differ greatly from the latter in the early stages, which shows that there is no close relationship. It will be absolutely necessary to keep the genus Brahmaea separate as a distinct family, and it is very noteworthy that a similar phenomenon exists in America, a very homogeneous family in many respects resembling Brahmaea also standing alone nearly without transitions and playing the same part in the fauna of the New World as Brahmaea in the Old World. These are the Ceratocampids, the largest species of which is produced from that grotesque and strange caterpillar, with its curved horns on the thorax which we figure on the cover of each part of this work in a defensive attitude and which perhaps those who are not familiar with the American fauna may have considered a product of the imagination.

The Brahmaeids are confined to the Old World and are so distributed that three species occur in the Palearctic Region, but not in Europe, just as many forms are Indian, and the same number belong to the Ethiopian fauna. They do not go far north and inhabit mountainous countries, have only one brood in the temperate zone, and as larvæ are fairly polyphagous. The larvæ grow slowly and pupate in the ground without a cocoon; the moths fly at night, and rest by day on tree-trunks and branches, where, with their wings in steep roof-shape and folded close together, they resemble fruits or pieces of bark. The moths are rather rarely seen, but the larvæ are common wherever they occur, and lately large quantities of material for breeding have been imported.

The characters of the family are those of the single genus Brahmaea.

* * * the larvae, when young, with long horns decreasing in length when the larva grows older, otherwise naked, soft, long and not strong; on deciduous trees.

The larva figured (Plate 2, fig. 11) was taken in August, 1902 (figured, August 2), at Hakodate, Oshima Province, Hokkaido (Yezo), on *ibotanoki* (*Ligustrum ibota* Siebold), but died without reaching the pupal stage. It is so well known amongst Japanese collectors that, although I have never succeeded in breeding the imago, I have no hesitation in referring the larva figured to *Brahmæa japonica*. Pryer [30] moreover comments on the larva as follows:

> Feeds on the privet; larva is smooth, bright green, marked with black, and has four thin black filaments over 1½ inches long on the foresegments and three on anterior [posterior]. Imago appears in March and April.

Pryer, however, speaks of the larva previous to the fifth molt when it loses all these filaments. My figure represents the larva in the fourth ? stage.

[30] Trans. Asiat. Soc. Japan 12 (1885) 53.

Nawa [31] records the life-history of the species and gives figures of the larva in its fourth ? and fifth ? stages with and without these curious filaments which are seven in number, also of the pupa and of the female imago. The following description is taken from my original figure:

Larva.—Fourth ? stage. Length, about 60 millimeters. Head black with a pattern of yellowish markings. Color pale whitish green, tinged with yellowish green patches subdorsally and laterally; a midlateral and spiracular series of black spots, streaks, and dashes; a suprapedal series of black elongated dashes situated on yellow patches; legs, prolegs, and claspers black, prolegs and claspers being dotted or streaked with white; ventrum blackish; segment 3 (counting head as segment 1) bears two black, wirelike filaments, much contorted, about 26 millimeters long; segment 4, two similar filaments of about equal length; segment 12 bears one similar, shorter, mediodorsal filament; the anal segment bears two filaments which are the shortest of the seven; all the filaments are more or less contorted and vary in length with the individual larva. The full-grown larva after the fifth molt measures from 90 to 110 millimeters and changes to yellowish brown. Nawa states that when it reaches maturity it loses these seven filaments and that it burrows in the earth where it pupates. He does not say, however, whether it forms a cocoon in the earth. My Japanese collector informed me that it makes a hard, subterranean cocoon, but I have never investigated the matter and am therefore unable to say whether it forms a cocoon or not. Nawa further says:

* * * there is only one brood in the year. The imago emerges in April [at Gifu, Omi Province], the ova hatch in May, the larvæ appear in May and June and the pupa passes the winter under ground until the following April. The larva feeds on *nedzumu-mochi* [(*Ligustrum japonica* Thunb.)] and *ibotanoki* [(*Ligustrum ibota* Siebold)].

Ibotanoki is also called *yachi-tamo* in Hakodate, Hokkaido. Sasaki [32] gives descriptions and figures of the larva, pupa, and male imago of *Brahmæa japonica*. He says:

* * * the larva emerges about the middle of May and feeds upon *nedzumi-mōchi* and *ibotanoki*. It is full grown by the middle of June and then pupates in the earth. It hibernates in the pupal stage and the imago emerges in April of the following year.

[31] Insect World (Konchū Sekai) 10 (1906) 415, pl. 11.

[32] Insects Injurious to Japanese Trees [Nihon Jūmoku Gaichūhen (Jap.)] ed. 3 (1910), pt. 3, 132, pl. 225.

I may mention that the larva of this species finds a place in the materia medica of the lower class Japanese as a specific for certain diseases, and Nawa corroborates me in this statement. He says:

> Popular superstition attributes to this larva some efficacy in cases of consumption but I have never heard of any cures effected in such cases.

I have often in my wanderings through the Bukenji Woods, near Yokohama, met men carrying shallow baskets filled with these larvæ and, on inquiry, have learned that they were to be sold to native apothecaries. They are sold by collectors at about 3 sen (1.5 cents gold) per larva, and after being dried in the sun are grilled over a fire. The retail price at which they are sold by the apothecary ranges from 4 to 5 sen per larva (2 to 2.5 cents gold). It has been stated to me that these dried larvæ are supposed to be efficacious in cases of piles, convulsions, and worms in children. As a matter of fact the lower class Japanese employ the larvæ of several other species of Heterocera for similar purposes, such as those of *Sciapteron regale* Butler wich feeds inside the stems of the wild grape, *yama-budō* (*Vitis coignetiæ* Pull.), and also of *Phassus signifer* Walker and *Phassus excrescens* Butler, which are found in the stmes of the *kusagi* (*Clerodendron tricotomum* Thunb.) and other trees. This however is not surprising when one considers that the Romans are reported to have regarded the larva of *Cossus ligniperda* L., also an internal feeder, as a great table delicacy.

The following description of the larva of the allied species *Brahmæa certhia* Fabr. (=*undulata* Brem. and Grey; *petiveri* Butler), from Amurland, northern and central China, and Korea, is given by Seitz and is useful for comparison with that of *B. japonica*, which it seems to resemble in some respects:

> Larva grey to blackish, when young with two horns rolled up at the ends on segment 2 and two similar ones on 3; the remaining segments only have small knobs, the anal segment bears an also very strongly curved horn resembling that of the Sphingidae. When full grown the larva is smooth, segments 2 and 3 swollen, on the anal segment a stumpy hump. Markings and colour very variable, frequently confined to a few small black streaks or bright-coloured spiracular dots. According to Staudinger the larvae of the East-Asiatic form are much more brightly marked and coloured than the almost uniformly dark larvæ of ledereri of Asia Minor [a form of *certhia* Fab.]. According to Korb the larvae often live in companies of from 20 to 30 specimens and prefer rather sunny sterile localities; until June or August on Privet, Syringa, Ash, Phillyrea and other trees; when disturbed they emit a cracking or crackling noise. They pupate without a cocoon in or on the ground beneath stones; pupa blackish,

very strongly glossy, clumsy, stumpy at both ends, deeply incised between the segments, rounded at the abdominal end, the cremaster a short point. The moth appears in June in Eastern Asia.

Imago.—Leech [33] remarks:

This is a variable species both as regards ground-colour and markings. Thus the former may be white or grey, and sometimes tinged with green; then the number of ocelli in central band and "rounded internal spot" is not the same in any two individuals comprised in my series of 15 specimens. The spot referred to sometimes has three ocelli across its centre on one wing, but its companion on the other wing has four. In all cases the number of ocelli, both in the spot and central band, is greater on one side than the other. Again the shape of the central band is subject to modification, and stages in the formation of the rounded internal spot from the lower portion of this band are exhibited in the specimens in my Japanese series; thus between an example in which the band is entire from costa to inner margin, and but slightly contracted below the middle, and a specimen with the rounded spot completely formed and quite independent, there are all the intermediate stages.

The Type of *Brahmæa japonica*, a male ?, is from Yokohama, Japan. The type of *B. nigrans* is from Japan.

Seitz [34] remarks as follows:

B. japonica Butl. (mniszechii Feld.) (35c). Smaller than the preceding [B. christophi Stgr.], more grey and often tinged with greenish. The median band of the forewing is strongly widened in the costal area; lighter and ornamented with small rings. These are nearly always asymmetrical; Leech did not find one symmetrical individual among 15 in Pryer's collection and the same applies to four specimens collected by me. The original of our figure also has on the right forewing (not reproduced) much fewer rings than on the wing figured. The median band also varies rather strongly in its inner marginal portion. Now it is more now less constricted on the lower median vein; but nearly always it forms an ocellus-like disc-patch. The species also varies considerably in the whole scheme of colouring and nigrans Butl., unknown to me in nature, is probably only a dark specimen; japonica is also closely allied to the Indian conchifera Butl. and is only a Northern form of wallichii Gray (spectabilis Hope), which we figure in Vol. 10, its ground-colour shading into greyish green and that of rufescens Butl. into reddish. These latter are Indian forms, which perhaps vary slightly according to locality, but belong to one species. But if Leech places wallichii with certhia, he is in error.—Japonica is not rare near Yokohama; occurs also in other localities on Hontō, [(Honshū)] and is also found in Hokkaidō.

Local distribution.—Honshu, Musashi Province, Yokohama, March and April (*Pryer*); Tokyo, March and April (*Wileman*):

[33] Proc. Zool. Soc. London (1888) 635, No. 257.
[34] Macrolep. Faun. Pal. 2 (1911) 228.

Sagami Province, Hiratsuka, April (*Wileman*). Matsumura records it from Hokkaido and Honshu.

Time of appearance.—Larva, May, June, July ? and August; imago, March, April, and May. In Yokohama and Tokyo, Honshu, the larva is found in May. It pupates in June and lies until March of the following year, the earliest emergences taking place about the middle of March. In fact this species is one of the earliest of the Japanese moths to appear in the spring. It is often to be taken at rest on the trunks of pines or oaks. The larva taken at Hakodate in August, from which my original figure was drawn, was exceptionally late in the season owing to the more northern latitude of Hokkaido.

General distribution.—Japan. Is a northern form of *wallichii* Gray (*spectabilis* Hope). (*Seitz.*)

ILLUSTRATIONS

[Drawings by Hisashi Kaido.]

PLATE 1

FIGS. 1 to 5. *Samia pryeri* Butler.
1, larva, third ? stage; *2*, larva, fourth ? stage; *3* and *4*, larva, fifth ? stage, dorsal and lateral aspects; *5*, larva, sixth ? stage; *5a*, food plant.

6 to 9. *Rhodinia fugax* Butler.
6, larva fifth ? stage; *7*, larva, sixth ? stage; *8*, paired dorsal tubercles on segment 4; *9*, tubercles on segments 11 and 12.

10 and 11. *Caligula jonasi* Butler.
10, full-grown larva, fifth ? stage; *11*, food plant.

PLATE 2

FIGS. 1 to 5. *Caligula jonasi* Butler.
1, young larva, third ? stage; *2*, food plant; *3*, thoracic segments, dorsal aspect; *4* and *5*, median and anal segments, dorsal aspect.

FIG. 6. *Dictyoploca japonica* Butler, full-grown larva.

FIGS. 7 to 10. *Aglia japonica* Leech.
7, larva; *8*, head of larva; *9*, extended transverse section of larva; *10*, food plant.

11 to 14. *Brahmæa japonica* Butler.
11, larva, fourth ? stage; *12*, food plant; *13*, head; *14*, head, enlarged.

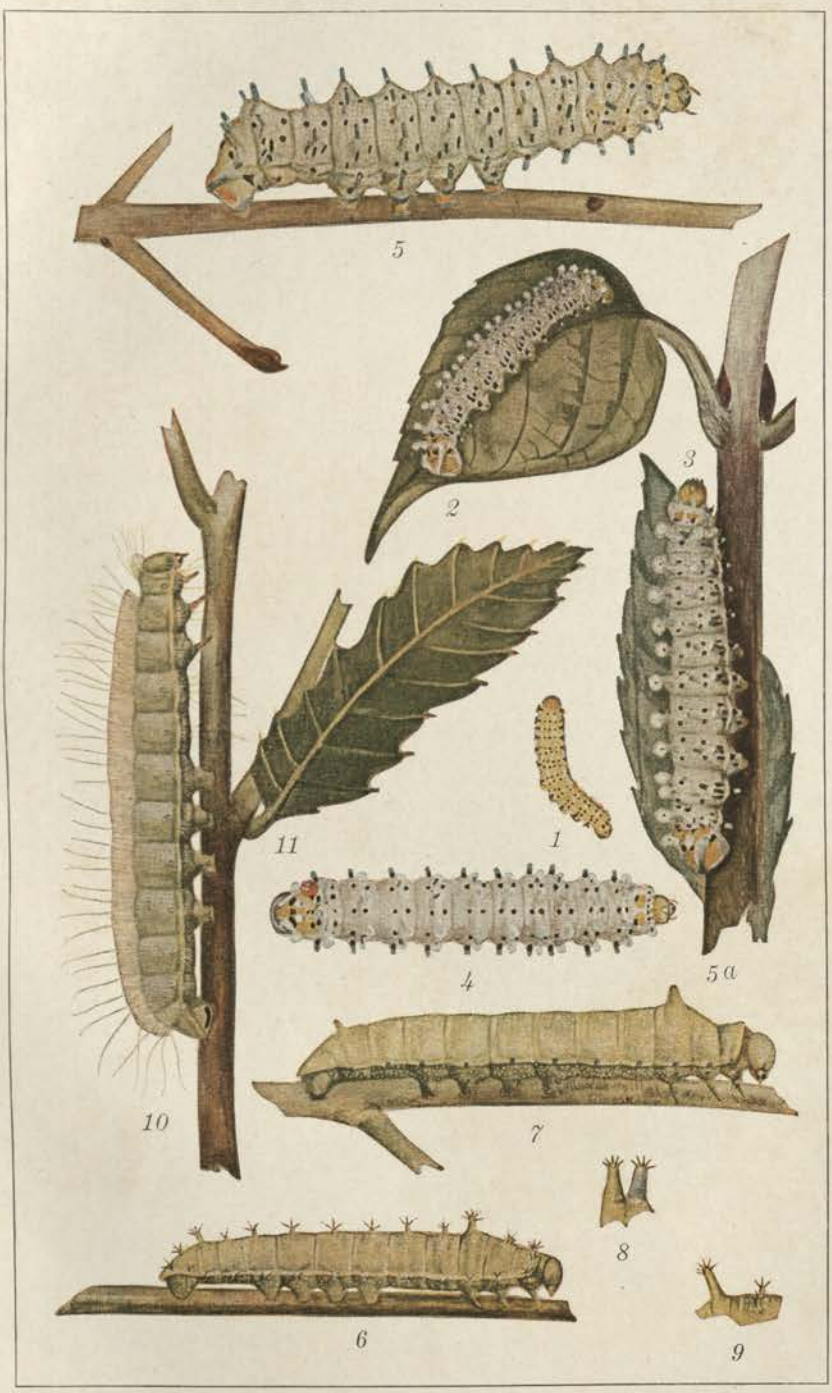

PLATE 1. LARVÆ OF JAPANESE LEPIDOPTERA.

PLATE 2. LARVÆ OF JAPANESE LEPIDOPTERA.

ANCIENT CAVE DWELLERS OF BATWAAN, MASBATE, PHILIPPINE ISLANDS

By WARREN D. SMITH

Head, Department of Geology, University of Oregon; and Acting Chief, Division of Mines, Bureau of Science

FIVE PLATES AND TWO TEXT FIGURES

INTRODUCTION

On a recent trip to inspect the mines of the Aroroy district of Masbate, a large triangular and forked island just south of the southeast end of Luzon, the writer had the opportunity to visit some ancient cave-dwellings in the interior of that island which was on the whole a most interesting experience. He was told of the existence of these caves by Mr. Paul Schwab, an American prospector, who has lived in that district since 1905. The caves were shown to Mr. Schwab by a Filipino who harvests rice in Batwaan Valley each year. It is reported that a Mr. Wilson, a lawyer of Masbate, who has some agricultural interests in the interior, had visited these caves or similar ones and had brought away some relics, but the writer has been unable to learn anything about his finds and, as far as is known, nothing about them has heretofore been published.

In the preparation of this article the writer has consulted Prof. H. O. Beyer, professor of anthropology in the University of the Philippines, but the author alone is responsible for the statements herein. No one has as yet made an exhaustive study of the caves or the materials found there and the writer wishes merely to place on record the information he now has, as a preliminary contribution to further study of these and other Philippine caves. Similar burial caves have been noted in other parts of the Archipelago, but aside from some notes by the traveler Jagor,[1] with reference to some caves on the coast of Samar and Leyte, with Virchow's important appendix, little or nothing has been written about prehistoric peoples in the Philippines, and to the writer's knowledge this is the first description of cave dwellings in the Philippines. Many stories and reports

[1] Jagor, Fedor, Viajes por Filipinas. Madrid (1875). This is a translation from the German.

are current about such, but they have not yet got into the literature.

Mr. E. H. Taylor, formerly of the Bureau of Science, who has traveled extensively in the Archipelago making zoölogical studies, has kindly contributed the following memorandum relative to some modern cave-dwellers on Coron Island:

> There is a limestone cave on Coron Island, directly across from the town of Coron on Busuanga Island, inhabited at the present time by a very primitive people known as Tagbanuas. At the time of my visit there was no one at home, but there were remains of fire, pots, a hammock, etc., testifying to the recent occupation of the cavern. This cave is about 20 meters above the sea and close to shore. In addition to the articles named there was a large kitchen midden consisting mainly of shells of edible molluscs and fragments of pottery. Just opposite this site are three small limestone islands. In one of these is a very small burial cave containing three cadavers, and one very recent coffin made of bamboo and nipa. According to report in Coron there are many Tagbanua cave dwellers on islands north of Palawan and on Culion.

Geography.—The site of the Batwaan caves is close to the trail from Aroroy to Mandaon and about five hours by foot from Mandaon and about eight from Aroroy; that is to say, about 32 kilometers from Aroroy and almost due south of that place (fig. 1). Batwaan valley is about 8 kilometers long and 5 kilometers wide, and roughly oval in shape. It is surrounded by a rim of low hills with fairly steep escarpments toward the valley and more gentle slopes away from the valley. The caves are found in a large limestone mesa (Plate 1), which rises about 100 meters above the floor of a large, flat-bottomed valley, through which runs Batwaan Creek. The general situation is shown in the sketch, fig. 2. The limestone mesa is roughly 0.5 kilometers long and 200 meters wide. The formations in this region are generally sedimentary, but this valley lies very close to the contact between the igneous rock of the central cordillera of the island and the Tertiary sediments which dip away from the cordillera to the west. On the trail to Batwaan from Aroroy there is much conglomerate exposed, and in the hills forming the western rim of Batwaan Valley there is conglomerate and sandstone with here and there patches of residual limestone. The large limestone mesa in the center of the valley is a residual block left by erosion. Formerly limestone probably overlay much of this region. This limestone is correlated with the lower member of the Malumbang limestone, which is lower Pliocene or upper Miocene in age. On fresh fracture the rock is compact and creamy white; it

weathers to a blue-gray. The caves in the limestone are the result of solution by water.

The caves.—The caves explored by Mr. Schwab and the writer are four in number, but there are several more in the hill. These four he has designated as follows: The great living cave, the burial cave, the ceremonial cave which is in reality a part of the living cave, and the great guano cave. In fig. 2 the general situation with reference to these caves is shown.

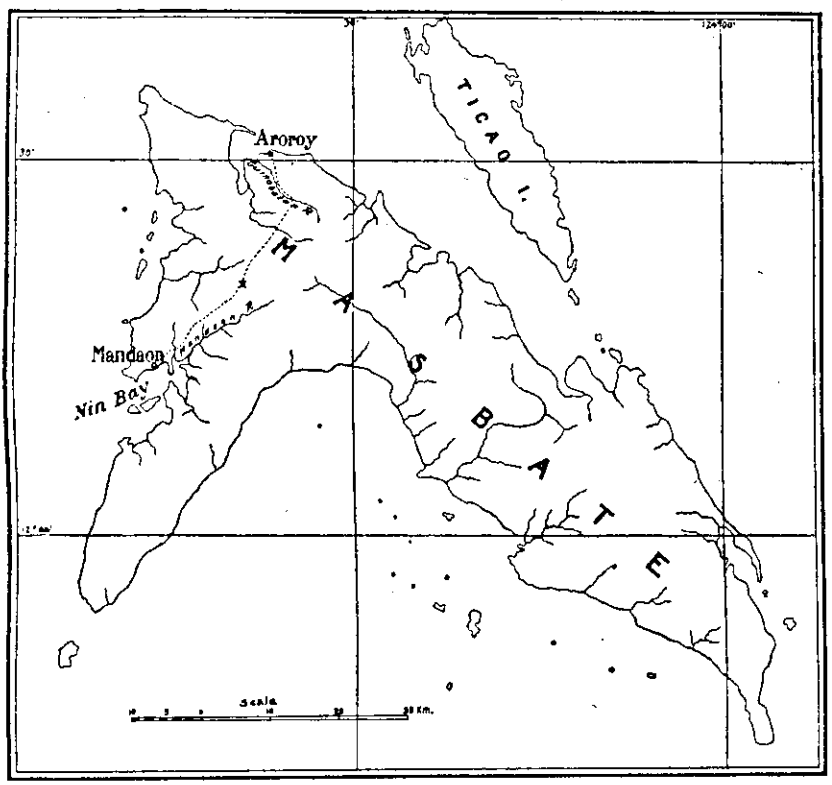

FIG. 1. Masbate Island; outline, showing cave site at X.

The great living cave is located at the southeast end of the hill and has a large opening which lets in plenty of light. The cave is somewhat semicircular in shape but is very irregular. It is perhaps 15 meters high and 20 meters long, and toward the back end of the cave the floor slopes upward to a chimney-like opening above. Special features of this and other caves of the hill are the large cylindrical holes in the roof. These are in some cases about a meter in diameter, but most of them are about 8 centimeters in diameter, and they do not go through

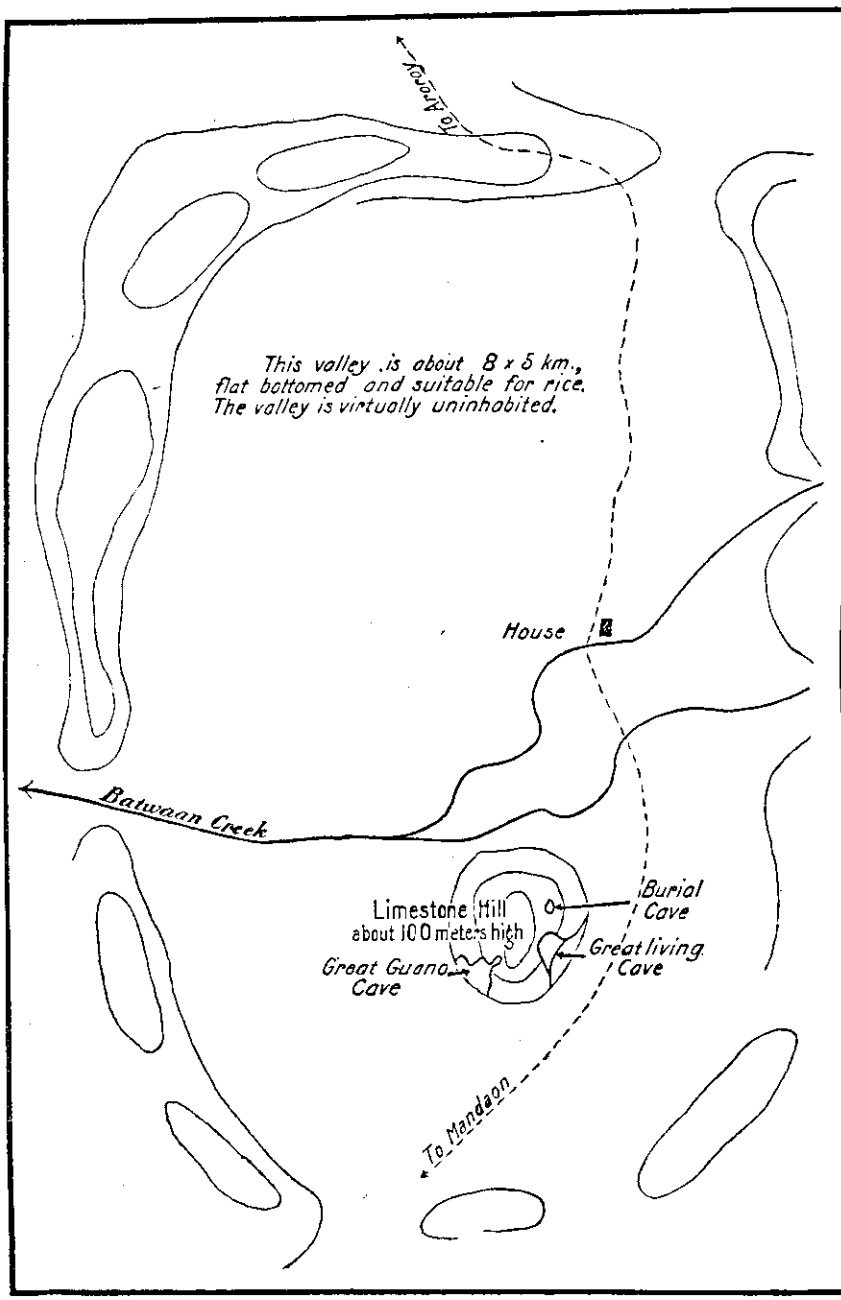

FIG. 2. Batwaan Valley and caves.

to the surface; usually swallows and various insects are found living in these cylindrical holes. The writer is at a loss to explain their origin as there is no indication of water having percolated through from the surface and dissolved the material. These holes are very symmetrical, very much resembling giant drill holes.

This cave is very dry, and anything found in it might have endured through many hundreds of years, as far as decomposition is concerned. The floor is somewhat sandy and is made up of loose blocks of limestone and fragments of pottery. It is quite evident from the amount of material on the surface that it would be easy to obtain many kilograms of broken pottery. On digging into the floor one comes across bits of charcoal from ancient fires, and many marine shells of species of *Arca* and *Turritella* which evidently formed one of the principal articles of diet of the people who inhabited the cave. These, being sea shells, of course, were brought from the ocean, probably from the nearest point, which is known as Nin Bay, about 15 kilometers to the southwest. There are also many deer teeth and broken jawbones of deer, indicating that these people were not only fishermen but hunters as well; in fact, this whole cave is one great kitchen midden.

Adjoining the great living cave, and virtually a part of it, is a second large chamber in which the floor slopes downward to a small outlet on the side of the hill. At the upper end of this slope there is a great flat block of limestone which forms a natural platform. There is a tradition among the Filipinos living in the neighborhood of this hill, one of whom accompanied the writer's party in their exploration, that this chamber was used in former times for a ceremony connected with marriage. There is also a tradition that the bride-to-be had to go into this chamber, where she would secure her trousseau from a shelf near the top of the cave. The people living in the valley at the present time have never taken part in these rites, but this story has been handed down to them with reference to this place.

The roof of this cave has a great hole open to the sky which lights up the whole place and has been instrumental in keeping the bats out of this and the living cave. Directly beneath this great natural skylight there are some trees growing in the center of the cave; the largest of these is not more than 6 centimeters in diameter and about 10 meters high. These indicate that probably the time necessary for them to grow, however much that might be, has elapsed since the cave was used.

The burial cave is a very small one, not over 8 meters from the entrace to the back wall, and not large enough to allow a person to stand upright in it. It is located on a shelf about 100 meters to the north of the living cave and perhaps 10 to 20 meters higher up. There is a very narrow ledge of rock leading up to it. Within this cave was found a heap of human bones among which there were forty-four human skulls. Here also was a head box about 1 meter long which would hold a row of five or six skulls. The head box was made of wood resembling molave, but was in a bad state of decay. This box had handles carved to represent the head of some animal, possibly a crocodile or a horse; it was impossible for the writer to tell which. There were fragments of a much smaller head box, about 0.5 meter in length, with nothing in it. At the far end of the cave there was a piece of basket work from which the bottom had rotted out. This type of basket work resembles the basket work, as far as shape is concerned, now found in the Islands. There was also a coconut shell with a hole in the bottom; and, curiously enough, in the same cave with these rather recent-looking artifacts were two stone implements.

On the west side of the hill and somewhat lower down than this cave is a great cavern with one fairly large entrance and in the rear a chimneylike opening to the surface. This cave is nearly semicircular in shape and resembles the interior of a cathedral. It is quite gloomy and is inhabited by innumerable bats. The floor is fairly level and is covered with bat guano. Apparently the deposit of guano in this cave is thick. In various parts leading off from the central chamber are some tunnels leading deep into the interior of the hill; these were not explored. The entrances to these various caves are well concealed by thick vegetation which has grown up around the lower slopes of the hill. The writer regrets exceedingly that the views taken of the interior of the caves did not turn out to be successful.

People inhabiting the cave.—The question as to the kind of people who lived here is of course open to some conjecture. It is certain that no people living on Masbate Island to-day inhabit caves; nor do the Filipinos living in Batwaan Valley (there are only two houses in the valley) know anything about the former dwellers in this interesting place, and with the exception of the two Filipino men who accompanied the party to the caves the people strictly avoid the locality. The writer has been in caves in northern Luzon where the Igorot people have buried their

dead, but he has never heretofore found any people living in the caves nor found any remains of people formerly living in them other than the bones which were buried there. Therefore, these caves are particularly interesting because we find the artifacts and kitchen middens, indicating not only that people lived here but that many people lived in them for a long period of time; and, furthermore, we are able to judge pretty well as to how they lived.

The skulls.—Most of the skulls examined showed artificial deformation which, history records, was practiced by some of the peoples living in the Islands when the Spaniards first came here; but, so far as the writer knows, no people at present living in the Philippines indulge in this primitive practice. An examination of the skulls (see Plate 2) leads him to believe that an earlier race of people than now inhabits Masbate frequented these caves. From a preliminary study only, Professor Beyer has told the writer that in his opinion the smaller of the two skulls was that of a Negrito, the larger, perhaps, of a Chinaman. He called particular attention to the rather unusual deformation of these skulls. The smaller one, although that of an adult, has an open suture along the median line in the anterior part. This may have been caused by the use of two separate blocks, one on each side, being bound on the head. In the case of the larger skull, a totally different method seems to have been used. In this there is no flattening, but there is a most unusual depression which begins just in front of and above one ear, continuing across the top of the cranium down to the corresponding place on the other side. It looks as if a band of some metal had been bound tightly about the skull in the early years. The frontal suture in this case is completely closed.

The artifacts.—From a study of the artifacts it seems that three different cultures are represented, the oldest being represented by the stone implements; the second, by the unglazed and ornamented pottery; and the last, by the glazed pottery, the badly decayed and rusty fragment of a metal lock, and the basket work. The fragments of pottery, shown in Plate 3, are particularly interesting, since, so far as is known, nothing like this is being made in the Philippines to-day, save among the pagans of eastern Mindanao. As a rule, Filipinos do not etch designs on their pottery; but, whenever they do attempt decorations of any kind (which is the exception) the patterns are painted on very crudely. Possibly the patterns on these old fragments from Batwaan have Javanese affinities. It seems fairly certain that they represent a very early culture stage in the Philippines.

Plate 4, fig. 1, shows an earthenware vessel of a design with which the writer is quite unfamiliar in the Philippines.

Plate 4, fig. 2, may be either the bottom part of a native stove or a fragment of a lid of a giant *tinaja* (water jar).

In Plate 5, fig. 2, is shown a bracelet cut from the top of a large *Conus* shell, while the other two fragments (fig. 1) are pieces of pipe bowls.

We come now to the most interesting of all the artifacts found in these caves, namely, the stone implements. So far as the writer knows there are only five of these known from the Philippines; Mr. Dean C. Worcester has two, the writer has one that was given him years ago by a prospector but about which he has no data, and the two that are pictured in Plate 5, figs. 3 and 4. The one shown in Plate 5, fig. 4, is made from a greenish colored felsite, probably a fine-grained diorite, and may have been used as a hide scraper. Professor Beyer has suggested to the writer that the implement was made from this rock because of its general resemblance to jade, from which material many Chinese implements were, and perhaps still are, manufactured.

Plate 5, fig. 3, shows an implement of a cherty material, which was undoubtedly used as a sort of combination hatchet and chisel. These stone implements, some believe, may have some historical connection with the ancient Chinese mining exploits on this island. The writer is not in accord with that view, since tools of this design or of this material would be of little use or effectiveness in mining operations. He is of the opinion, on the other hand, that these stone implements represent a true indigenous stone-age culture in the Philippines belonging to the Neolithic Period.

The writer disclaims any pretense to a special training in ethnology; he has described these finds in the hope that qualified persons may become interested enough to make further investigations. However, the writer is sufficiently informed along those lines to realize the importance of a complete study of this subject, if any safe conclusion as to early movements of peoples in the Pacific area is to be arrived at. He agrees with a recent statement of Hrdlicka that the solution of Pacific anthropology and ethnology will have to be arrived at by way of a more complete study of the Continent of Asia and the festoons of islands off its east coast. The writer believes that the Philippines are in a strategic ethnologic position with respect to such a study.

ILLUSTRATIONS

PLATE 1

Limestone mesa, site of the Batwaan caves.

PLATE 2

Skulls found in the burial cave.

PLATE 3

Fragments of decorated pottery found in the living cave.

PLATE 4

Earthenware utensils found in living cave.

PLATE 5

FIG. 1. Pipe bowls found in the living cave.
2. A bracelet made of a *Conus* shell, found in the living cave.
3. A stone hatchet found in the burial cave.
4. A stone scraper found in the burial cave.

TEXT FIGURES

FIG. 1. Outline map of Masbate Island. X marks the cave site.
2. Map of Batwaan valley and caves.

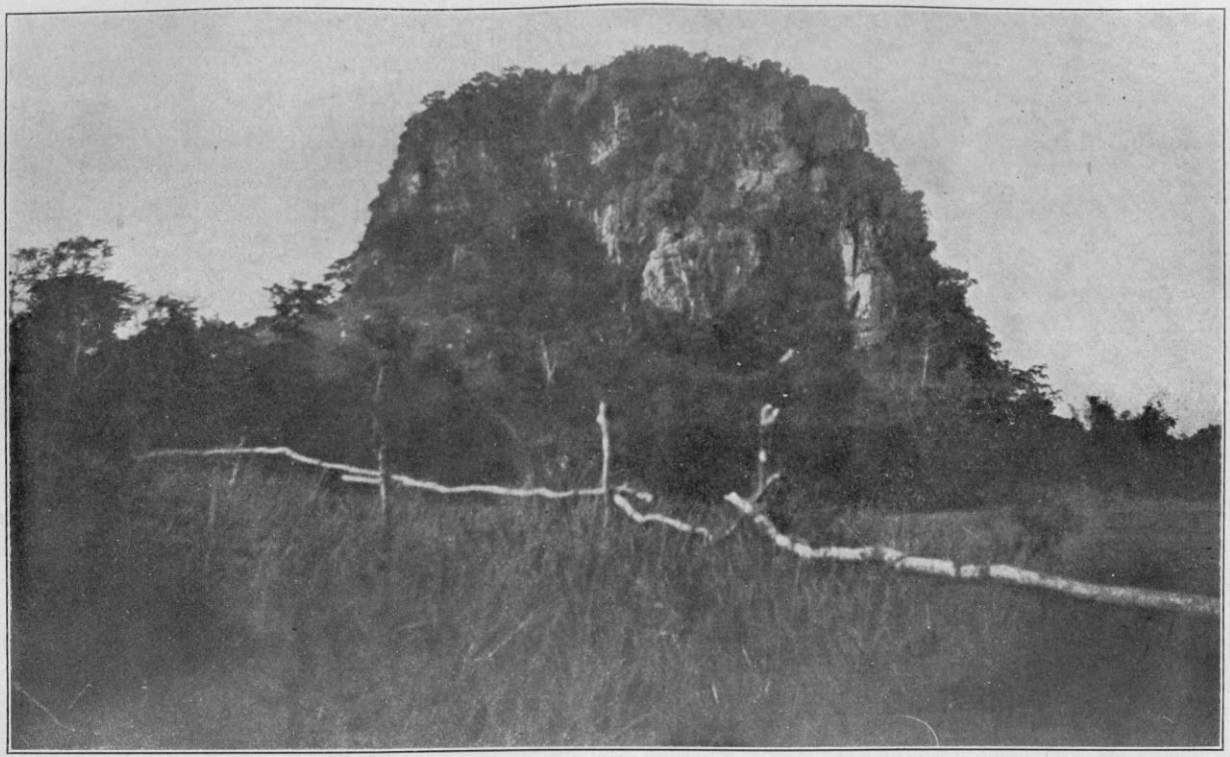

PLATE 1. LIMESTONE MESA, SITE OF THE BATWAAN CAVES.

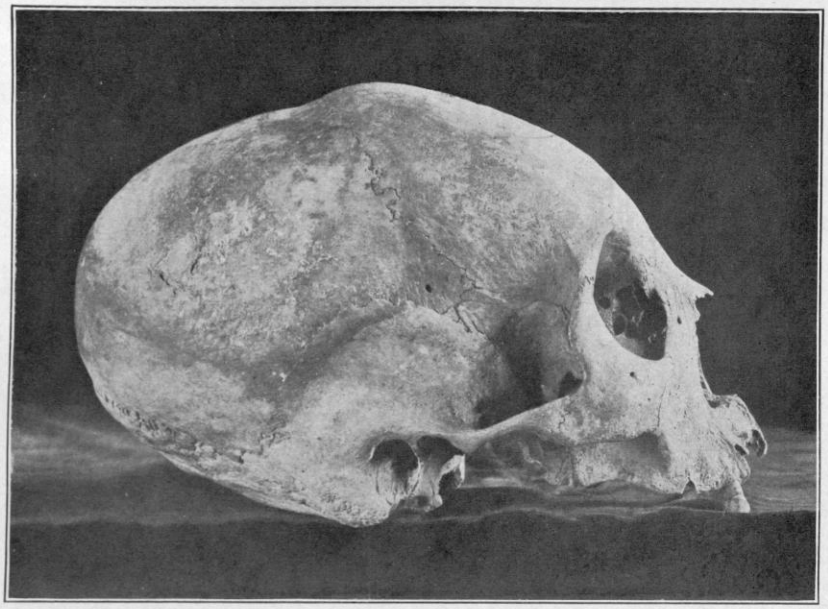

Fig. 1.

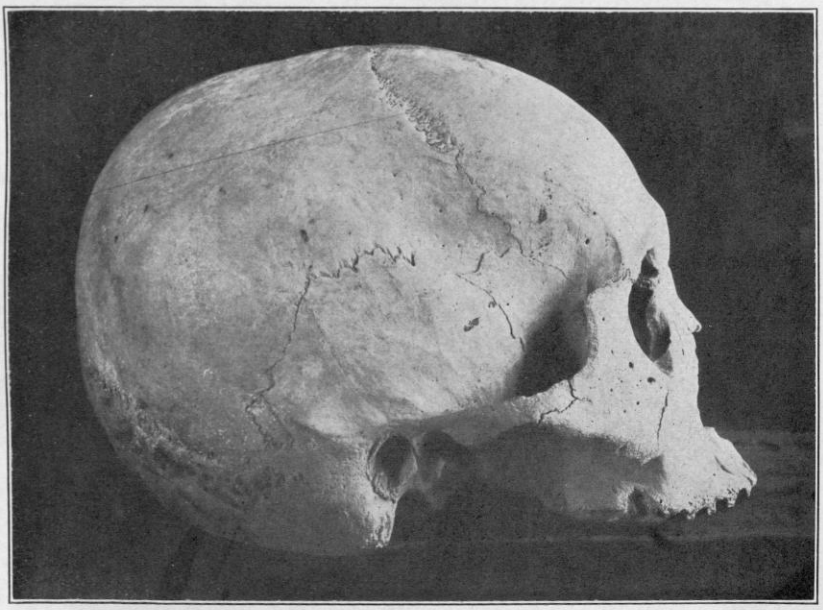

Fig. 2.

PLATE 2. SKULLS FROM THE BURIAL CAVE.

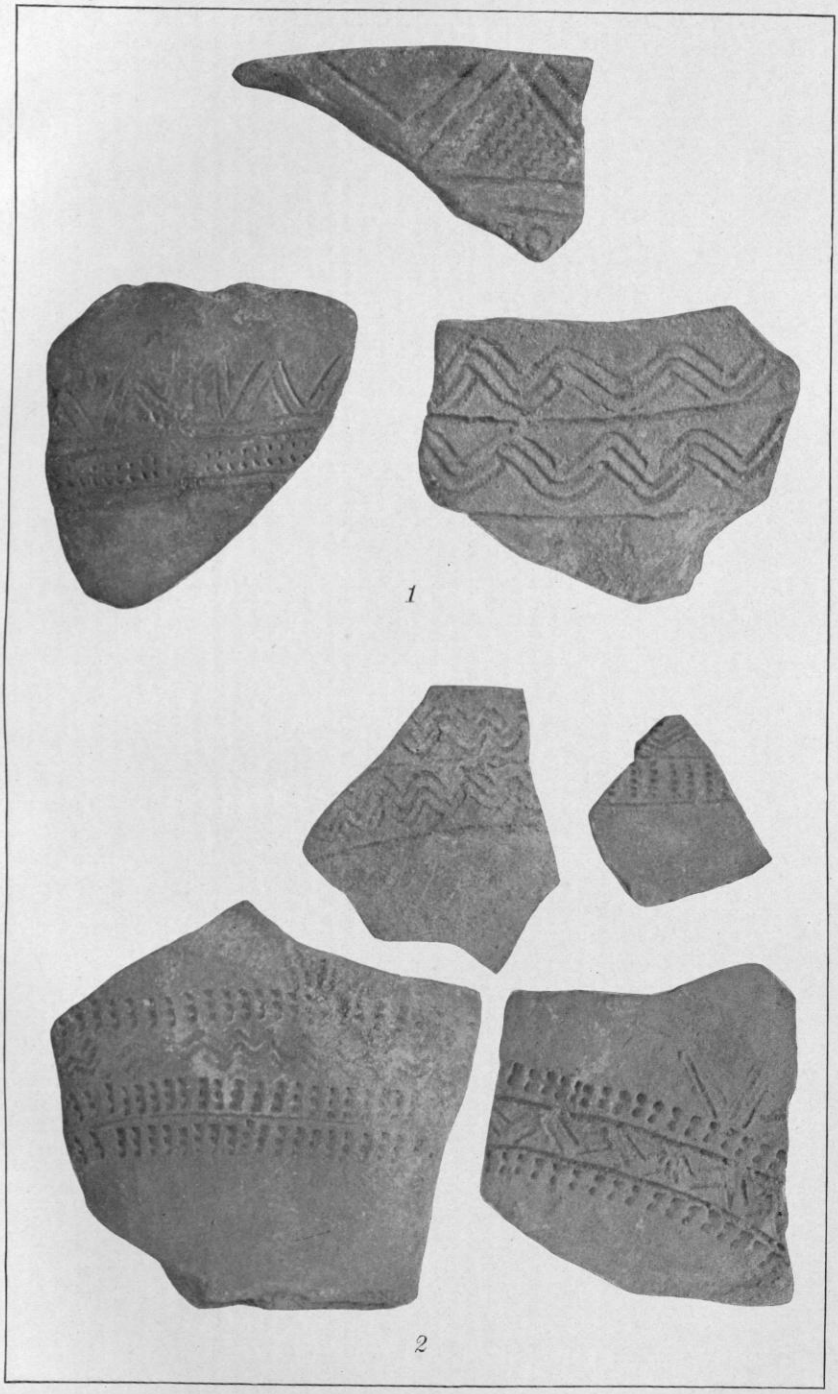

PLATE 3. FRAGMENTS OF DECORATED POTTERY FROM THE LIVING CAVE.

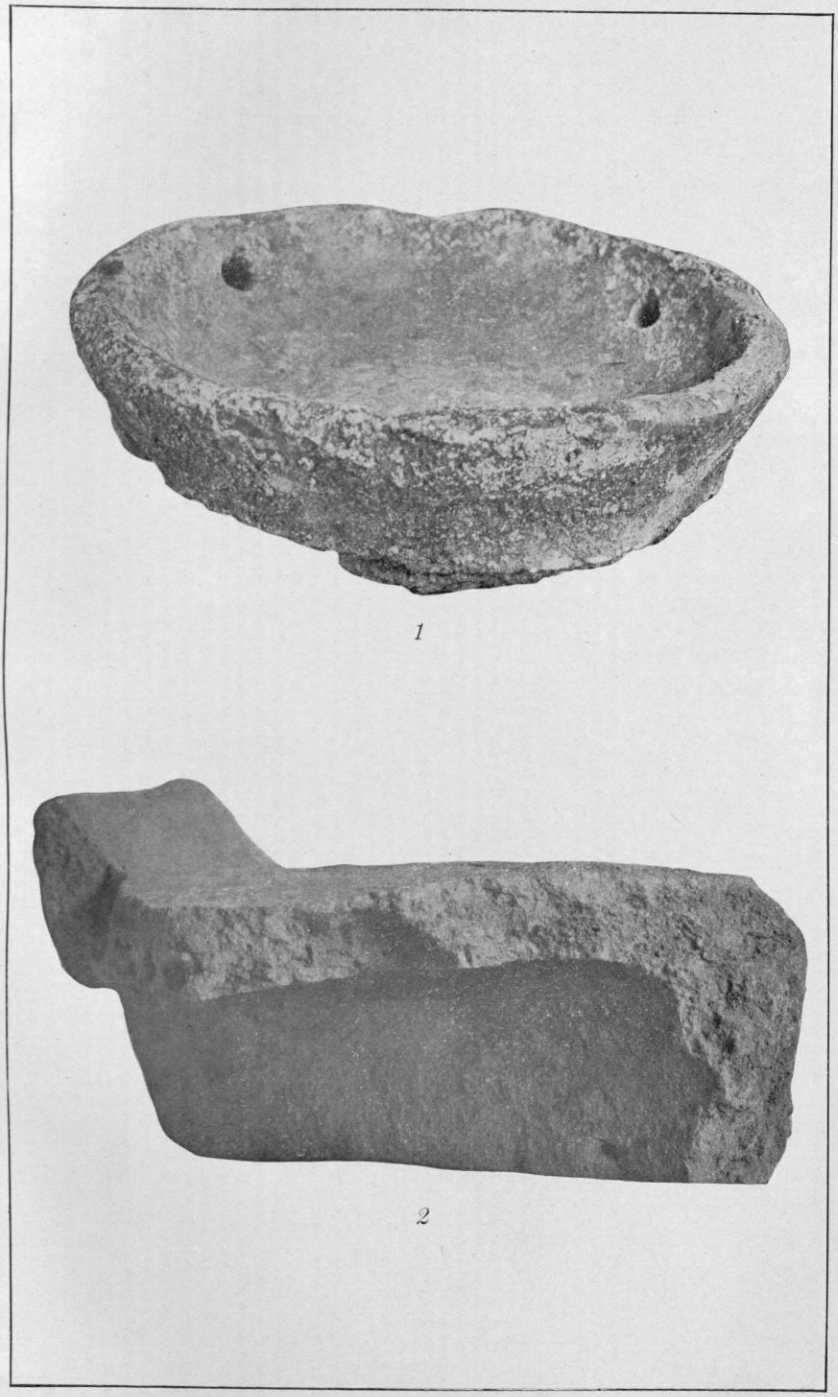

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PLATE 4. EARTHENWARE UTENSILS FROM THE LIVING CAVE.

1

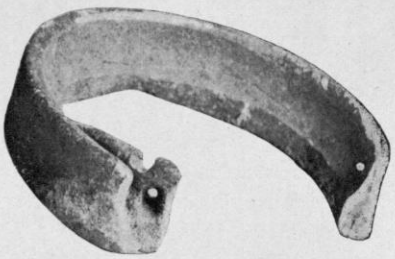

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PLATE 5. ARTICLES FROM BATWAAN CAVES.

OPISTHORCHIS WARDI, A NEW SPECIES OF LIVER FLUKE FROM THE CAT IN THE PHILIPPINE ISLANDS

By LAWRENCE D. WHARTON

Dean and Professor of Zoölogy, Junior College of Liberal Arts, University of the Philippines, Cebu

ONE PLATE

In making postmortem examinations of cats for parasites at the College of Medicine and Surgery in Manila, the bile ducts of nearly 50 per cent of the specimens examined have been found to be infested with a species of *Opisthorchis*. The first specimens obtained were thought to be *Opisthorchis felineus* (Rivolta, 1884), and I sent a mounted specimen to Dr. H. B. Ward under that name. He very kindly sent me drawings of the type specimens of *O. felineus* and *O. pseudo-felineus* and pointed out several differences between my specimen and the other two forms mentioned. Since that time I have collected a large series of specimens from over twenty cats, all from Manila, and it was found that the characters which Doctor Ward had mentioned are constant and of sufficient importance to justify considering this form a distinct species. I therefore propose the name *Opisthorchis wardi* for this species.

Opisthorchis wardi sp. nov. Plate 1, fig. 2.

Specific diagnosis.—Body elongated, transparent, flat; length in preserved specimens, 6 to 9 millimeters; breadth, 1.6 to 2.2; living specimens, somewhat larger; anterior end conical, with a slight constriction at the level of the ventral sucker, posterior end rounded, occasionally with a small projection around the excretory pore; oral sucker 0.17 to 0.28 millimeter in diameter; ventral sucker about the same size and about one-fourth of the length of the body from the anterior end; pharynx 112 to 174 μ in diameter; œsophagus two to three times as long as the pharynx; intestinal cæcæ reach almost to the posterior end of the body; excretory pore at the posterior border; excretory bladder narrow, and extending to in front of the testes; testes in posterior fourth of the body, deeply lobed, anterior with four lobes,

posterior with five lobes; ovary in the median line in front of the testes, with three distinct lobes, two to the right and one to the left; large saclike receptaculum seminis behind the ovary; Laurier's canal present; coils of the uterus extensive, filling nearly all of the middle half of the body; vitellaria lateral, extending from behind the ventral sucker to the level of the ovary, acini not in distinct groups, no distinct division into anterior and posterior portions; eggs, 28 to 30 μ by 11 μ.

Habitat and distribution.—Specimens found in the bile ducts of domestic cats from Luzon, Philippine Islands. Since coming to Cebu to live I have examined many cats with the hope of finding this parasite, but so far I have not found it on this island. I have had no opportunity to look for it anywhere else in the Islands.

The characters which distinguish this species from *O. felineus* (see Plate 1, fig. 1) are the relatively great length of the œsophagus, the distinct division of the testes and ovary into lobes, the simple arrangement of the vitellaria, and the greater extent of the uterine coils.

ILLUSTRATION

PLATE 1

FIG. 1. *Opisthorchis felineus* (Rivolta), from the type specimen of Doctor Ward.

2. *Opisthorchis wardi* sp. nov., from the type specimen in collection of Doctor Ward; cotypes in collection of L. D. Wharton.

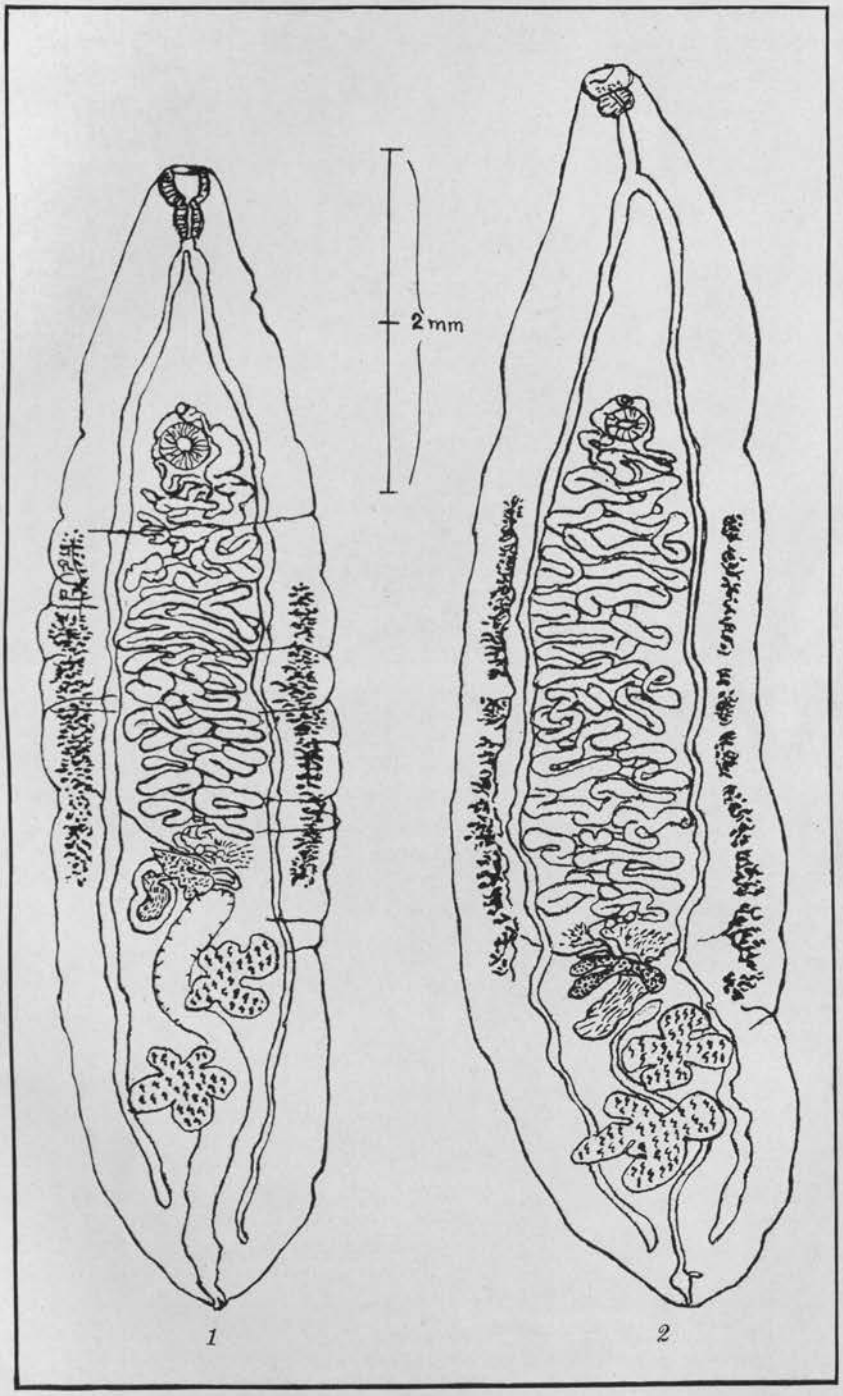

PLATE 1. OPISTHORCHIS FELINEUS (RIVOLTA) AND O. WARDI SP. NOV.

NOTES ON PHILIPPINE ALCYONARIA

PART VI: NEW PHILIPPINE PENNATULARIA (SEA PENS) OF THE GENUS LITUARIA

By S. F. LIGHT

Professor of Zoölogy, College of Liberal Arts, University of the Philippines

The Philippine Pennatularia have been little studied, only eleven species being known from the Islands, all from the collections of Semper [1] and the *Challenger*.[2]

The present report deals with the specimens belonging to the genus *Lituaria* in the collection of the department of zoölogy, College of Liberal Arts, University of the Philippines, which represent four species, all new to science.

The only other representative of the suborder Sessiliflorae in the collection is the *Policella manillensis* of Kölliker,[1] here reported for the first time since Kölliker.

In this report I have adopted the systematic arrangement of the group suggested by Kükenthal in his revision,[3] and have followed him closely in the diagnosis of the genus *Lituaria* and the key to the species of the genus.

Suborder SESSILIFLORÆ

Polyps arising singly and directly from the rachis.

Section Pennatulina radiata

Polyps arising on all sides of the rachis.

Family VERETILLIDÆ

Polyps without a distinct calyx.

Genus LITUARIA Valenciennes MS., 1850

Colony club-shaped. Autozooids widely separated, scattered or in longitudinal rows. Siphonozooids very numerous, filling all the spaces between the autozooids. Axis of varying length and

[1] Kölliker, A., Abh. Senckenb. Naturf. Ges. 7 (1869–1870) 109–256; 8 (1872) 85–275.

[2] Kölliker, A., Report of the Voyage of H. M. S. Challenger during the years 1873–76 1[3] (1880).

[3] Kükenthal, W., Anthozoa, Pennatularia, Das Tierreich. Franz Eilhard Schulze, 43 Lieferung (1915).

always four-sided in the rachis region. Spicules are biscuit-shaped plates with warts and thorns, crosses, rods, and capstans with branched or warted ends.

This genus was instituted in 1850 by Valenciennes[4] in his manuscript for Pallas's long-known species *Pennatula phalloides*. Recently three other species have been added. Two of these, *L. habereri* Balss[5] and *L. hicksoni* Thomson and Simpson,[6] are new. One old species, the *Clavella* (*Sarcobelemnon, Veretillum*) *australasiæ* of J. E. Gray[7] has been referred to this genus by Kükenthal and Brock.[8]

Our collection contains specimens of four distinct types belonging to this genus, none of which can be identified with any of the four known species. These results might well be open to doubt were it not for the facts that these are the first species of *Lituaria* reported from the Islands, that the alcyonarian fauna of the Philippines is still to a great extent unknown, and that where it has been studied it has shown a surprisingly large percentage of new species.

Key to the species of Lituaria.

1. Axis with longitudinal furrows.....2.
   Axis without longitudinal furrows.
   L. australasiæ (Gray) Kükenthal and Brock.
2. Axis with outgrowths on the upper end.
   L. phalloides (Pallas) Valenciennes.
   Axis without processes or outgrowths.....3.
3. Axis not extending to the upper end of the rachis.....
   .....L. kükenthali sp. nov.
   Axis extending to the upper end of the rachis.....4.
4. Rachis of same length as stalk.....5.
   Rachis longer than the stalk.....6.
5. Polyp spicules up to 0.12 millimeter long.....L. habereri Balss.
   Polyp spicules up to 0.20 millimeter long.
   L. hicksoni Thomson and Simpson.
6. Base of retracted autozooids directed upward, outer spiculated region triangular.....L. philippinensis sp. nov.
   Base of retracted autozooids directed outward and upward, outer spiculated region not triangular.....7.
7. Spicules of rachis averaging 0.13 millimeter in length, with long thorns.....L. molle sp nov.
   Spicules of rachis averaging 0.085 millimeter in length, little branched at ends.....L. breve sp. nov.

[4] Milne-Edwards, H., and Haime, Palaeontographical Society Monographs, Intr. p. 84.

[5] Balss, Abh. Bayer. Ak. suppl. 1, p. 81.

[6] Thomson and Simpson, Alcyonaria of the Investigator 2: 310.

[7] Gray, J. E., Catalogue Sea-Pens, British Museum, 33.

[8] Kükenthal and Brock, Ergb. Tiefsee Exp. 13: 117–170.

Lituaria kükenthali sp. nov.

Type.—No. C. 682 in the zoölogical collection, College of Liberal Arts, University of the Philippines; collected in Port Galera Bay on the north coast of Mindoro Island, by L. E. Griffin.

The rather slender, club-shaped colony, from 80 to 120 millimeters in length, ends in a slender stalk, from 5 to 12 millimeters in maximum diameter and from one-half to three-fourths as long as the rachis. The stalk shows no distinct swollen area. The rachis increases in size from the stalk to the blunt upper end. At or near its tip it reaches a maximum diameter of from 10 to 16 millimeters. The lower part of the rachis, while distinctly not a part of the stalk, bears no autozooids and in some colonies but few siphonozooids and might easily be mistaken for the upper portion of the stalk, in which case the stalk would appear to be of about the same length as the rachis.

The axis extends from the midregion of the stalk to a point about one-third the length of the rachis from the upper end of the colony. It tapers from a blunt end in the rachis region to a pointed but not recurved end in the stalk. It is four-sided and shows two deep longitudinal grooves in the rachis region which join over the blunt upper end. Those portions of the colony above and below the ends of the axis are often bent at an obtuse angle.

The large polyps are scattered at fairly regular intervals of from 1 to 3 millimeters, but are not in distinct rows. In expansion they are from 6 to 8 millimeters in length and from 2 to 3 millimeters in diameter at the base. They are transparent with the exception of a triangular brown area on the upper surface of the base of each polyp which gives the colony, particularly in contraction, a very characteristic spotted appearance. This spot fades in alcohol, leaving a transparent area. The extensile portion of the polyp contains no spicules and is completely retractile within low but quite distinct, outwardly and upwardly directed, spiculated basal portions which may or may not appear 8-rayed, depending upon the amount of contraction of the colony.

The siphonozooids, which are very numerous, filling all the spaces between the autozooids, appear near the base of the rachis to lie in crowded but distinct longitudinal rows.

The spicules, which are numerous only on the basal, non-retractile regions of the autozooids, are very irregular in shape and size, having the form of irregular clubs, crosses, capstans, etc., usually with divided ends and sculptured surfaces. They range in length from about 0.05 to 0.13 millimeter. The following are characteristic measurements in millimeters:

Capstans: 0.117 x 0.065 x 0.104; 0.104 x 0.039 x 0.052; 0.117 x 0.0455 x 0.08; 0.0845 x 0.026 x 0.065.

Clubs: 0.075 x 0.03.

Crosses: 0.0975 x 0.039; 0.0845 x 0.039; 0.117 x 0.039.

Irregular forms: 0.1235 x 0.091; 0.104 x 0.039.

There are no spicules in the inner or outer portions of the stalk.

The rachis is a grayish white, the spiculated regions a dead white, and the stalk grayish yellow in formalin or alcohol.

Measurements of specimens of Lituaria kükenthali sp. nov.

No.	Length of—			Maximum diameter of—	
	Colony.	Rachis.	Stalk.	Rachis.	Stalk.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*
1	122	75	47	15	12
2	103	75	38	15	11
3	113	75	38	[a]11	10
4	108	70	38	15	12
5	106	70	36	[b]12	10
6	103	60	43	15	9
7	90	55	35	15	8
8	102	60	42	16	9
9	101	62	39	13	9
10	92	62	30	14	9
11	83	55	33	13	12.5
12	87	44	33	10	6
13	82	49	33	13	7
14	82	52	30	10	10
15	85	55	30	10	10
16	82	52	30	12	8
17	81	51	25	11	8
18	83	43	30	10	10
19	84	41	33	10	6
20	86	43	42	7	6

[a] Siphonozooids lacking on lower 15 millimeters of rachis.
[b] Siphonozooids very scarce on lower rachis.

This species differs from the four known species of the genus in the presence of the brown area on the upper basal portion of each autozooid which gives the contracted colony a characteristic

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spotted appearance. It differs from all but *L. australasiæ* in that the axis does not extend to the upper end of the colony, and from *L. australasiæ* in that the axis is deeply grooved on two sides in the region of the rachis and in the large size of its autozooids. From *L. hicksoni,* to which it is apparently most nearly related, it differs, aside from the difference in the length of the axis and the presence of the brown spot on the upper basal portion of the polyp, in the greater length of the rachis as compared with the stalk, in that the siphonozooids are arranged in distinct longitudinal rows, and in that the autozooids are considerably smaller.

I have named this species after Dr. Willy Kükenthal, whose revision of the Pennatularia has greatly facilitated systematic work in that group.

Lituaria philippinensis sp. nov.

Type.—No. C. 2459 in the Zoölogical collection, College of Liberal Arts, University of the Philippines; collected from Port Galera Bay, Mindoro, by R. P. Cowles.

The colony is slender and, with the exception of the lower portion of the stalk, rigid. The rachis is somewhat longer than the stalk and has a maximum diameter slightly less than that of the somewhat swollen lower portion of the stalk. The axis, which extends from the midportion of the stalk to the extreme tip of the rachis, is four-sided, slender, recurved at its lower end, and grooved on two sides throughout its whole length. It tapers from the middle of the rachis to the very slender lower tip, and less so toward the upper end, which is bluntly pointed. The grooves do not join over the upper end.

The polyps are scattered or in indistinct transverse rows or whorls, being from 2 to 3 millimeters apart in the long axis of the colony, and from 1 to 2 millimeters apart in the transverse axis. They are completely retractile within upwardly directed, flaplike, basal portions, which have a triangular, spiculated region on their outer surfaces. The polyps have transparent white walls with black or brown tentacles, or white tentacles and a brown stomodæum. The siphonozooids are numerous and distinct, irregularly arranged, each with a small nonretractile basal portion similar to that of the autozooids.

The spicules are unbranched or bluntly branched, sculptured capstans averaging 0.13 millimeter in length and 0.025 in central diameter.

Measurements of specimens of Lituaria philippinensis sp. nov.

No.	Length of—			Maximum diameter of—	
	Colony.	Rachis.	Stalk.	Rachis.	Stalk.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*
1	103	60	53	6	7
2	87	55	32	7	9
3	92	50	42	6	7

This species differs from *L. phalloides* in the absence of any outgrowth from the upper end of the axis; from *L. hicksoni* in that the colony is much slenderer, that the nonretractile basal portions of the autozooids are of quite different shape and appearance, and that the spicules are smaller; from *L. australasiæ* in that the axis is deeply grooved; and from *L. kükenthali* in that the axis extends to the upper end of the rachis and in the absence of the characteristic brown area on the upper part of the polyp base.

From *L. habereri*, to which it is apparently most nearly related, it differs, so far as I have been able to determine from the rather meager description in Kükenthal's revision (I do not have access to Balss' description), in that the rachis is longer than the stalk; that the axis does not extend throughout the entire colony, ending below in the middle of the stalk; in that there are no spicules in the stalk rind; and in that the colors are different.

Lituaria molle sp. nov.

Type.—No. C. 2457 in the zoölogical collection, College of Liberal Arts, University of the Philippines; collected from Port Galera Bay, Mindoro, by L. E. Griffin.

The rachis, which is somewhat longer than the slender stalk, increases in size from the stalk to the blunt upper end where it reaches a maximum diameter of 10 millimeters. The entire colony is expanded and soft: hence the specific name.

The large, irregularly scattered autozooids reach a length of 10 millimeters and a basal diameter of 2 to 3 millimeters. The upper portion of the autozooids and the tentacles are brown. The numerous long, closely set pinnules are transparent white, as are the polyp walls. The lower portion of the stomodæum is

brownish black and shows through the transparent polyp walls. The siphonozooids are few and scattered.

The four-sided axis extends from about the midregion of the stalk to the tip of the rachis. It is slender, pointed, and reflexed below and increases in size to a point near the upper end from which it tapers slightly to the bluntly pointed tip, showing two deep longitudinal furrows which do not meet over the upper end.

There are no polyp spicules. Those of the rind of the rachis are rather large capstans and stars with much-branched ends. They average 0.11 millimeter in length and are scattered, being thickest in the region around the base of the polyp, forming, in the upper region of the rachis, fairly distinct verruca-like structures.

The stalk rind contains scattered, unbranched, sculptured clubs, plates, and capstans. The colony, aside from the polyps, is yellow in formalin.

Measurements of a specimen of Lituaria molle sp. nov.

	mm.
Length of colony	130
Length of rachis	70
Length of stalk	60
Maximum diameter of rachis	10
Maximum diameter of stalk	9

This species, while based on a single specimen, seems distinct enough to stand without confusion. It differs from the other three Philippine species, among other things, in having spicules in the stalk rind; from *L. australasiæ* in having a grooved axis; from *L. phalloides* in having no outgrowths from the axis; from *L. habereri* and *L. hicksoni* in having a rachis longer than the stalk and in details of spiculation and in color.

Lituaria breve sp. nov.

Type.—No. 2458 [9] in the zoölogical collection, College of Liberal Arts, University of the Philippines; collected from Port Galera Bay, Mindoro, by S. F. Light.

The rachis is about twice as long as the slender stalk. The colony is slightly curved and tapers from about the middle of the rachis to the two ends. The autozooids are few, large, and irregularly scattered. In contraction they lie in outwardly and

[9] This species, like the others described in this paper, was described some time ago. Since then, unfortunately, the type specimens have been misplaced. In view of the very distinct characters of the species, however, I have considered it permissible to publish the description, in spite of the loss, temporary it is to be hoped, of the type specimens.

somewhat upwardly directed, heavily spiculated, verruca-like basal regions about 2 millimeters in diameter, whose large size in proportion to the diameter of the rachis gives the colony a characteristic, irregular appearance.

The siphonozooids are numerous and irregularly arranged and have spiculated nonretractile basal regions, similar to those of the autozooids, and are about 0.8 millimeter in diameter. In the lower one-third of the rachis the zooids are nonspiculated and 8-rayed, brown on the outer surface.

The axis is cylindrical in the stalk region ending in a slender recurved tip. It is four-sided in the rachis region, shows two shallow longitudinal furrows, and tapers toward the tip where, for a distance of about 10 millimeters, it is slightly roughened.

There are no spicules in the retractile portions of the polyps, in the stalk rind or in the rind of the lower part of the rachis. Those in the upper portion of the rachis are present only in the verruca-like basal portions of the autozooids and siphonozooids. They are small, averaging about 0.085 millimeter in length, sculptured, but little-branched, consisting mainly of plates constricted in the middle, crosses, and capstans.

The two colonies differ decidedly in detail due to the fact that one is immature and the larger colony has evidently been broken at some time and regenerated. The above description is an attempt to give a specific diagnosis. A study of new specimens will probably lead to some changes, but the species is so clearly distinct that it seemed justifiable to establish it here. Below are separate descriptions of the two specimens, in so far as they differ.

Specimen A.—Apparently a mature specimen. Length of colony, 69 millimeters; of rachis 49; of stalk 20. Maximum diameter of rachis 6 millimeters, stalk 4. Stalk constricted at point of union with the rachis. Rachis tapering to a point.

The axis, which extends from near the base of the stalk to the tip of the rachis, consists of two parts; the upper part, 25 millimeters long, has become attached throughout most of its length to the flat ungrooved side of the lower portion.

Specimen B; immature.—A very slender colony 40 millimeters in length. Rachis and stalk of about the same length, due apparently to the fact that the 8-rayed zooids found in the lower portion of the rachis of the mature colony have not

developed. The autozooids and siphonozooids are somewhat smaller than in the larger colony, but they have the same form and arrangement. The spiculation is the same.

The similarity in the form of the colony, in the arrangement and form of the autozooids and siphonozooids, and in the spiculation mark these two specimens as belonging to the same, very characteristic new species.

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